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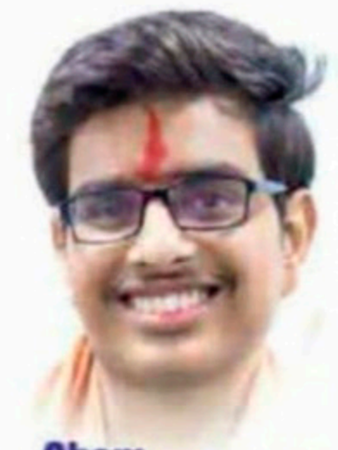

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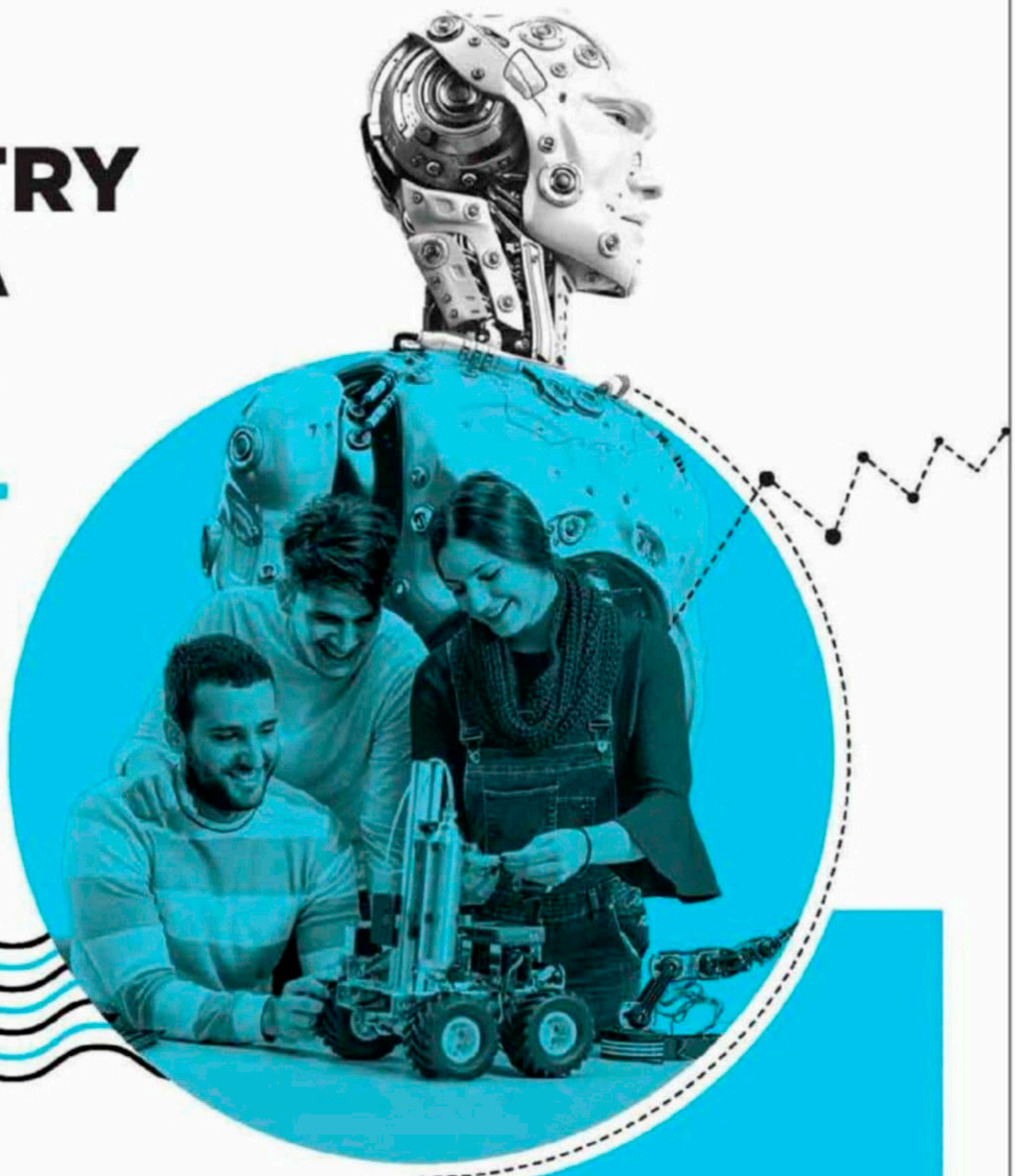

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CONTENTS

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CHEMISTRY MUSING

PROBLEM SET 81

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET with additional study material.

In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.

The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

1. *X*, *Y* and *Z* in the following reactions sequence are

$X \xrightarrow{Br_2 \text{ water}}$ Decolourisation

$X \xrightarrow{\text{Conc. } H_2SO_4}$ Addition product

$X \xrightarrow{HBr} Y \xrightarrow{NaOH} Z \xrightarrow{[O]} CH_3CH_2CH_2-\underset{\underset{O}{\|}}{C}-CH_2CH_3$

(a) $X = CH_3CH_2CH=CHCH_3$,
$Y = CH_3CH_2CH(Br)CH(Br)CH_2CH_3$,
$Z = CH_3CH_2CH_3$

(b) $X = CH_3CH=CHCH_3$,
$Y = CH_3CH(Br)CH(Br)CH_3$,
$Z = CH_3CH_2CH_2OH$

(c) $X = CH_3CH_2CH=CHCH_2CH_3$,
$Y = CH_3CH_2\underset{\underset{Br}{|}}{C}HCH_2CH_2CH_3$,
$Z = CH_3CH_2CH_2\underset{\underset{OH}{|}}{C}HCH_2CH_3$

(d) $X = CH_3CH_2CH_2CH=CHCH_3$,
$Y = CH_3CH_2CH_2CH_2CH_2CH_2Br$,
$Z = CH_3CH_2CH_2CH_2OH$

2. A colourless mixture of two compounds '*A*' and '*B*' (in excess) is soluble in H_2O. '*A*' turns blue litmus red and '*B*' turns red litmus blue. '*A*' gives white precipitate with '*B*' which dissolves in excess of '*B*' forming '*C*'. '*A*' when placed in moist air atmosphere gives fumes and can form dimer. '*A*' gives white precipitate with NH_4Cl and NH_4OH which is soluble in '*B*'. '*A*', '*B*' and '*C*' respectively are

(a) AgCl, KOH and KCl
(b) $AlCl_3$, NaOH and $NaAlO_2$
(c) $PbCl_2$, KOH and $Al(OH)_3$
(d) $MgCl_2$, NaH and $NaAlO_2$

3. Select reagents and conditions from the following list, and choose the correct option listing them in the order to convert ethyl 3-oxobutanoate to ethyl 4-oxopentanoate.

(1) Sodium ethoxide in ethanol
(2) Ethanol + Acid catalyst
(3) H_3O^+; Heat
(4) CO_2 then H_3O^+
(5) Mg in ether
(6) PBr_3
(7) $NaBH_4$ in alcohol
(8) CH_2I_2 in ether; Zn – Cu
(9) $BrCH_2COOC_2H_5$
(10) $(CH_3CO)_2O$; Pyridine

(a) 1, 9, 3, then 2
(b) 7, 6, 5, 10, then 2
(c) 3, 7, 6, 5, 10, then 2
(d) 8, 3, then 2

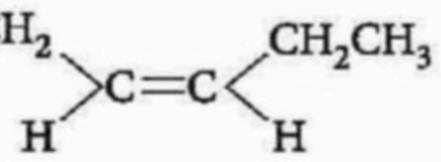
4. For the following sequence of reactions,

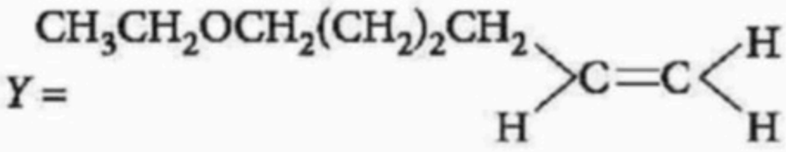
$HO-CH_2-(CH_2)_2-CH_2-C\equiv CH\ (A) \xrightarrow{NaNH_2} B$

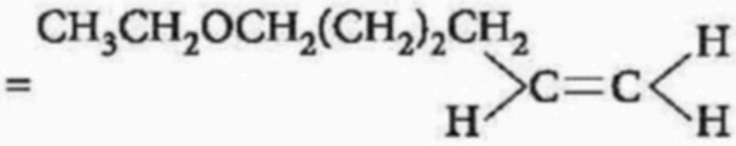
Final product $\xleftarrow[\text{Lindlar's catalyst}]{H_2} D \xleftarrow{EtOH} C \xleftarrow{CH_3CH_2Br} B$

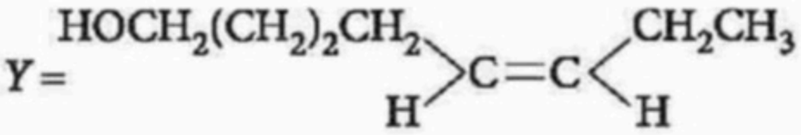
If *A* is treated with excess of $NaNH_2$, then final product will be *X* and if *A* is treated with only one equivalent of $NaNH_2$, then final product will be *Y*. (Remaining reagents are reacted as indicated in both the cases). Which of the following justify *X* and *Y* correctly?

(a) *X* and *Y* both are same molecules but *X* will be in higher yield.

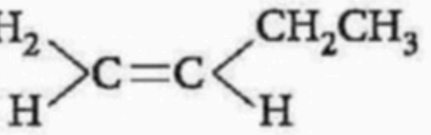
(b) $X =$ 

$Y =$ 

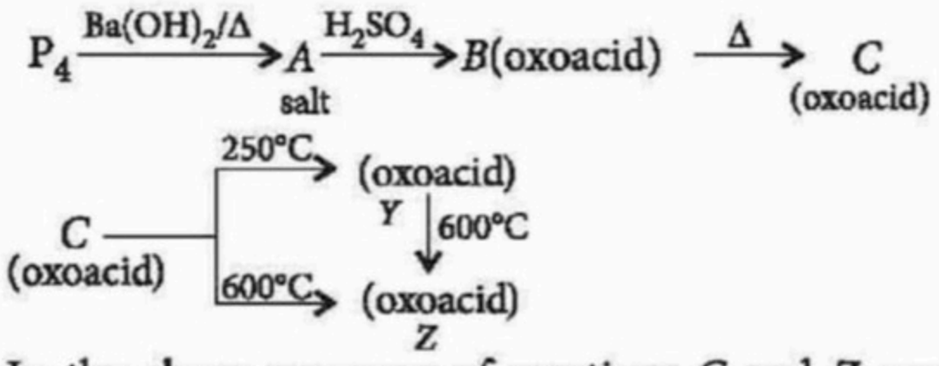
(c) $X =$ 

$Y =$ 

(d) $X = HOCH_2(CH_2)_2CH_2CH_2CH_2CH=CH_2$

$Y =$ 

5. Consider the following sequence of reactions,



In the above sequence of reactions C and Z are respectively

(a) H_3PO_2 and H_3PO_4 (b) H_3PO_4 and $H_4P_2O_7$

(c) H_3PO_4 and HPO_3 (d) H_3PO_3 and H_3PO_4

JEE ADVANCED

6. 1 mole of an ideal gas $A(C_{v,m} = 3R)$ and 2 moles of an ideal gas B are $\left(C_{v,m} = \frac{3}{2}R\right)$ taken in a container and expanded reversibly and adiabatically from 1 litre to 4 litres starting from initial temperature of 320 K. ΔU for the process is

(a) $-240\ R$ (b) $240\ R$

(c) $480\ R$ (d) $-960\ R$.

COMPREHENSION

Tollens' reagent is used for the detection of aldehyde when a solution of $AgNO_3$ is added to glucose with NH_4OH then gluconic acid is formed.

$Ag^+ + e^- \longrightarrow Ag;\ E^\circ_{red} = 0.8\ V$

$C_6H_{12}O_6 + H_2O \longrightarrow$ Gluconic acid $+ 2H^+ + 2e^-;$
$(C_6H_{12}O_7)$ $E^\circ_{oxd} = -0.05\ V$

$[Ag(NH_3)_2]^+ + e^- \longrightarrow Ag_{(s)} + 2NH_3\ ;\ E^\circ_{red} = 0.337\ V$

[Given : $2.303 \times RT/F = -0.0591$ and $F/RT = 38.92$ at 298 K]

7. When ammonia is added to the solution, pH is raised to 11. Which half-cell reaction is affected by pH and by how much?

(a) E_{oxd} will increase by a factor of 0.65 from E°_{oxd}.

(b) E_{oxd} will decrease by a factor of 0.65 from E°_{oxd}.

(c) E_{red} will increase by a factor of 0.65 from E°_{red}.

(d) E_{red} will decrease by a factor of 0.65 from E°_{red}.

8. Ammonia is always added in this reaction. Which of the following must be incorrect?

(a) NH_3 combines with Ag^+ to form a complex.

(b) $[Ag(NH_3)_2]^+$ is a stronger oxidising agent than Ag^+.

(c) In absence of NH_3 silver salt of gluconic acid is formed.

(d) NH_3 has affected the standard reduction potential of glucose/gluconic acid electrode.

NUMERICAL VALUE

9. Hydroxylamine reduces iron(III) according to the equation,

$2NH_2OH + 4Fe^{3+} \rightarrow N_2O\uparrow + H_2O + 4Fe^{2+} + 4H^+$

Iron(II) thus produced is estimated by titration with a standard permanganate solution. The reaction is,

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

A 10 mL sample of hydroxylamine solution was diluted to 1 litre. 50 mL of this diluted solution was boiled with an excess of iron(III) solution. The resulting solution required 12 mL of 0.02 M $KMnO_4$ solution for complete oxidation of iron(II). The weight of hydroxylamine in one litre of the original solution is _____.

(H = 1, N = 14, O = 16, K = 39, Mn = 55, Fe = 56)

10. In a certain reaction, B^{n+} is getting converted to $B^{(n+4)+}$ in solution. The rate constant of this reaction is measured by titrating a volume of the solution with a reducing agent which reacts only with B^{n+} and $B^{(n+4)+}$. In the process, it converts B^{n+} to $B^{(n+2)+}$ and $B^{(n+4)+}$ to $B^{(n-1)+}$. At $t = 0$, the volume of the reagent consumed is 25 mL and at $t = 10$ minutes, the volume used is 32 mL. The rate constant for the conversion of B^{n+} to $B^{(n+4)+}$ is found out in the form of $x \times 10^{-2}\ min^{-1}$. The value of x is _____.

(Assuming it to be a first order reaction.)

GEAR UP FOR JEE MAIN 2020

with Numerical Value Type Questions

1. The compound used for the preparation of UF_6 in the enrichment of $^{235}_{92}U$ is

(a) AlF_3 (b) CaF_2 (c) HF (d) ClF_3

2. The turbidity of a polymer solution measures

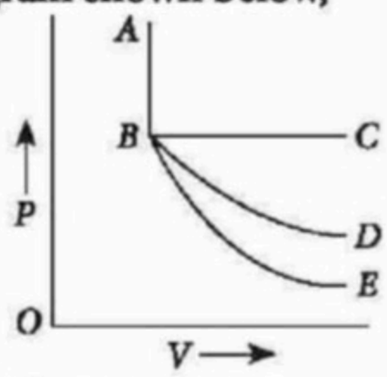
(a) light absorbed by solution
(b) light transmitted by the solution
(c) light scattered by the solution
(d) none of the above.

3. 8 mol of a gas AB_3 are introduced into a 1.0 dm^3 vessel. It dissociates as, $2AB_{3(g)} \rightleftharpoons A_{2(g)} + 3B_{2(g)}$

At equilibrium, 2 mol of A_2 is found to be present. The equilibrium constant for the reaction is

(a) 2 $mol^2\ L^{-2}$ (b) 3 $mol^2\ L^{-2}$
(c) 27 $mol^2\ L^{-2}$ (d) 36 $mol^2\ L^{-2}$.

4. For a *P-V* diagram shown below,



Which of the following options is correct?

(a) *AB* represents adiabatic process.
(b) *AB* represents isothermal process.
(c) *AB* represents isobaric process.
(d) *AB* represents isochoric process.

5. Chile saltpetre is the ore of

(a) Ca (b) Na (c) Mg (d) K

6. The correct decreasing order of acidic characters of the following is

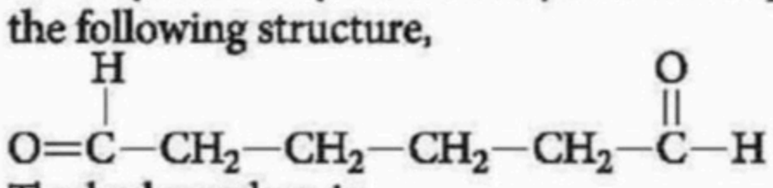
I. $CH{\equiv}CH$ II.  III. 

(a) I > II > III (b) II > I > III
(c) III > II > I (d) I > III > II

7. Tetraethyl lead (TEL) in petrol was used as anti-knocking agent, which creates lead pollution. In order to avoid lead pollution, the substituent of TEL is used in unleaded-petrol. The substituent is denoted as

(a) AK–33–X (b) BK–33–X
(c) CK–33–X (d) DK–33–X

8. A hydrocarbon of formula, C_6H_{10} absorbs only one molecule of H_2 upon catalytic hydrogenation. Upon ozonolysis, the hydrocarbon yields a compound of the following structure,



The hydrocarbon is

(a) cyclohexane (b) cyclohexyne
(c) cyclohexene (d) cyclobutane.

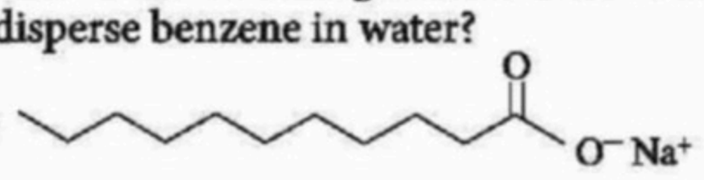
9. Functionally active form of vitamin D is

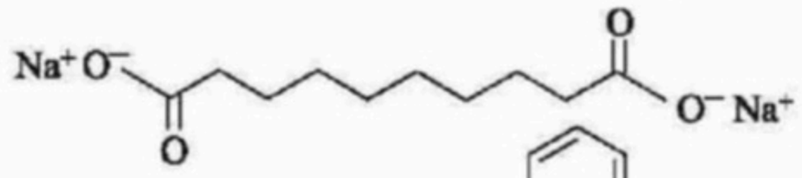
(a) cholecalciferol (b) ergocalciferol
(c) dehydrocholesterol (d) calcitriol.

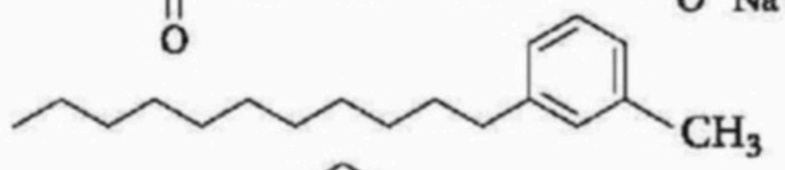
10. Milk turns sour at 40°C three times as faster as at 0°C. The energy of activation for souring of milk is

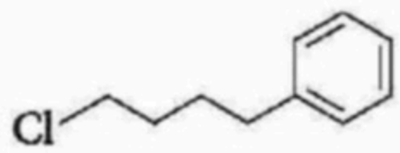
(a) 4.694 kcal (b) 2.605 kcal
(c) 6.623 kcal (d) none of these.

11. Which of the following molecules is most suitable to disperse benzene in water?

(a) 

(b) 

(c) 

(d) 

12. Two ionic solids *AB* and *CB* crystallise in the same lattice. If $\frac{r_{A^+}}{r_{B^-}}$ and $\frac{r_{C^+}}{r_{B^-}}$ are 0.50 and 0.70, respectively then the ratio of edge length of *AB* and *CB* is

(a) 0.68 (b) 0.78 (c) 0.88 (d) 0.98

13. The hybridisation, oxidation number of central metal ion and shape of Wilkinson's catalyst are

(a) dsp^2, +1, square planar
(b) sp^3, +4, tetrahedral
(c) sp^3d, +2, trigonal bipyramidal
(d) d^2sp^3, +6, octahedral.

14. If x_M, x_P, and x_V are mole fraction, pressure fraction and volume fraction respectively of a gaseous mixture, then which of the following relations is correct?

(a) $x_M = \frac{1}{x_P} \times \frac{1}{x_V}$ (b) $\frac{1}{x_M} = x_P = \frac{1}{x_V}$

(c) $x_M = x_P \times x_V$ (d) $\frac{1}{x_P} = \frac{1}{x_M} = \frac{1}{x_V}$

15. What is the value of effective nuclear charge for 4*s* electron of zinc atom?

(a) 23.65 (b) 21.15 (c) 4.35 (d) 8.85

16. Mercury sticks to the surface of the glass when it comes in contact with

(a) Hg_2O (b) HNO_3 (c) O_3 (d) grease.

17. In the following reactions sequence, *X* is

$$X \xrightarrow{\text{Bromination}} Y \xrightarrow{NaNO_2/HCl} Z \xrightarrow[C_2H_5OH]{\text{Boiling}} \text{Sym -tribromobenzene}$$

(a) benzoic acid (b) salicylic acid

(c) phenol (d) aniline.

18. Roasted gold ore + $CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$

$[X] + Zn \longrightarrow [Y] + Au$

[*X*] and [*Y*] respectively are

(a) $X = [Au(CN)_2]^-$; $Y = [Zn(CN)_4]^{2-}$

(b) $X = [Au(CN)_4]^{3-}$; $Y = [Zn(CN)_4]^{2-}$

(c) $X = [Au(CN)_2]^-$; $Y = [Zn(CN)_6]^{4-}$

(d) $X = [Au(CN)_4]^{3-}$; $Y = [Zn(CN)_6]^{4-}$

19. In the following reactions sequence, *T* is

$$\text{Glycerol} \xrightarrow{HCl} P \xrightarrow{[O]} Q \xrightarrow{HCN} R \xrightarrow{KCN_{(alc.)}} S \xrightarrow{H_2O/H^+} T$$

(a) citric acid (b) ascorbic acid

(c) tartaric acid (d) saccharic acid.

20. An ester (*A*) with molecular formula, $C_9H_{10}O_2$ was treated with excess of CH_3MgBr and the compound so formed was treated with conc. H_2SO_4 to form olefin (*B*). Ozonolysis of (*B*) gave ketone with formula, C_8H_8O which shows positive iodoform test. The structure of (*A*) is

(a) $C_6H_5COOC_2H_5$ (b) $CH_3OCH_2COC_6H_5$

(c) $CH_3CO-C_6H_4-COCH_3$

(d) $C_6H_5COOC_6H_5$

NUMERICAL VALUE TYPE

21. Equal weights of ethane and hydrogen are mixed in an empty vessel at 25°C. The fraction of the total pressure exerted by hydrogen is _____.

22. 19 g fused $SnCl_2$ was electrolysed using inert electrodes. 0.119 g Sn was deposited at cathode. If nothing was given out during electrolysis, the ratio of mass of $SnCl_2$ and $SnCl_4$ in fused state after electrolysis is _____.

23. The freezing point of 0.02 mole fraction of acetic acid in benzene is 277.4 K. Acetic acid exists as a dimer. Freezing point of benzene is 278.4 K and heat of fusion of benzene is 10.042 kJ mol^{-1}. The equilibrium constant for dimerisation is _____.

24. A stationary He^+ ion emitted a photon corresponding to the first line of the Lyman series. That photon liberated a photoelectron from a stationary H-atom in ground state. The velocity of photoelectron is $x \times 10^8$ cm sec^{-1} then the value of *x* is _____.

($R_H = 109678\ cm^{-1}$)

25. The H—O—H bond angle in the water molecule is 105°, the H—O bond distance being 0.94 Å. The dipole moment for the molecule is 1.85 D. The charge on the oxygen atom is $x \times 10^{-10}$ esu-cm then the value of *x* is _____.

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SOLUTIONS

1. (d): ClF_3 is used for preparation of UF_6 in the enrichment of $^{235}_{92}U$.

$U_{(g)} + 3ClF_{3(l)} \longrightarrow UF_{6(g)} + 3ClF_{(g)}$

2. (c)

3. (c): $2AB_{3(g)} \rightleftharpoons A_{2(g)} + 3B_{2(g)}$

Initial	8	0	0
At eq.	$\frac{8-2x}{1}$	$\frac{x}{1}$	$\frac{3x}{1}$

Since, volume = 1 dm^3 = 1 L

At eq. $[A_2] = 2\ mol = x$

$\therefore\ [AB_3] = 8 - 2 \times 2 = 4\ M$

$[A_2] = 2\ M$

$[B_2] = 3 \times 2 = 6\ M$

$$K = \frac{[B_2]^3[A_2]}{[AB_3]^2} = \frac{6\times6\times6\times2}{4\times4} = 27\ mol^2\ L^{-2}$$

4. (d): In *AB* process, volume does not change hence, it is isochoric process.

5. (b) **6. (b)**

7. (a): AK–33–X ; its chemical name is cyclopentadienylmanganese tricarbonyl.

8. (c) **9. (d)**

10. (a): $T_1 = 0°C = 273\,K$; Rate constant = k_1

$T_2 = 40°C = 40 + 273 = 313\ K$, $k_2 = 3k_1$

$$\log\frac{k_2}{k_1}=\frac{E_a}{2.303R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$$

$$\Rightarrow \log\frac{3k_1}{k_1}=\frac{E_a}{2.303\times2}\left(\frac{1}{273}-\frac{1}{313}\right)$$

$$E_a=\frac{273\times313}{40}\times2.303\times2\times\log 3$$

$= 4694 \text{ cal} = 4.694 \text{ kcal}$

11. (c)

12. (c) : $\frac{r_{A^+}}{r_{B^-}}=0.50$ and $\frac{r_{C^+}}{r_{B^-}}=0.70$

$$\Rightarrow \frac{r_{A^+}+r_{B^-}}{r_{B^-}}=1+0.5=1.5$$

Similarly, $\frac{r_{C^+}+r_{B^-}}{r_{B^-}}=1.70$ $\therefore$ $\frac{r_{A^+}+r_{B^-}}{r_{C^+}+r_{B^-}}=\frac{1.5}{1.70}=0.88$

Also, $a_{AB}=2(r_{A^+}+r_{B^-})$ and $a_{CB}=2(r_{C^+}+r_{B^-})$

$\therefore$ $\frac{a_{AB}}{a_{CB}}=\frac{1.5}{1.70}=0.88$

13. (a)

14. (c) : $x_M=\frac{n_1}{n_T}$; n_1 = Moles of one gas,

n_T = Total no. of moles of mixture of gases

$x_P=\frac{P_1}{P_T}$; $\begin{cases}P_1=\text{Pressure of one gas}\\P_T=\text{Total pressure of mixture of gases}\end{cases}$

$x_V=\frac{V_1}{V_T}$; $\begin{cases}V_1=\text{Volume of one gas;}\\V_T=\text{Total volume of mixture of gases}\end{cases}$

According to gas equation,

$P_1V_1=n_1RT$ ...(i)

and, $P_TV_T=n_TRT$ ...(ii)

From eqns. (i) and (ii), we get

$n_1=\frac{P_1V_1}{RT}$ ...(iii) $n_T=\frac{P_TV_T}{RT}$ ...(iv)

Divide eqn. (iii) by eqn. (iv),

$$\frac{n_1}{n_T}=x_M=\frac{P_1V_1\times RT}{RT\times P_TV_T}=\frac{P_1}{P_T}\times\frac{V_1}{V_T}=x_P\times x_V$$

$\therefore$ $x_M=x_P\times x_V$

15. (c) : For Zn ($Z=30$): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$

For 4*s* electron :

1 electron shields from the same group,

18 electrons shield from the penultimate shell,

10 electrons shield from the inner shells.

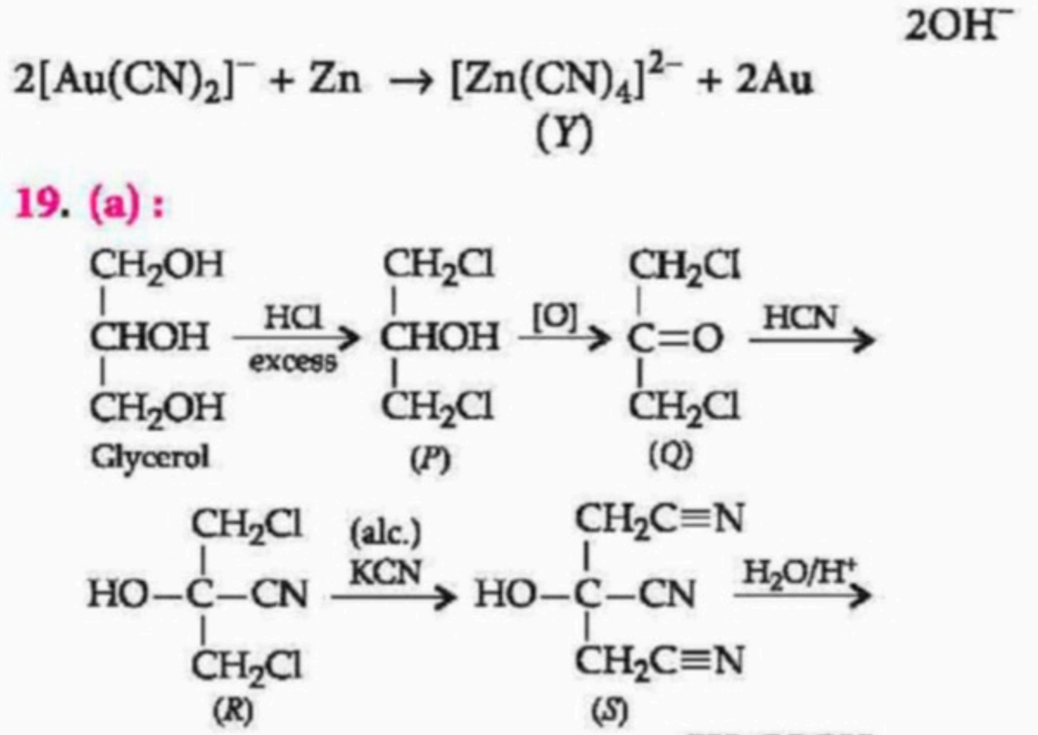
Different contributions are calculated by using Slater's rule as follows :

$1\times0.35+18\times0.85+10\times1.0=25.65$

Effective nuclear charge $= Z-\sigma=30-25.65=4.35$

16. (c)

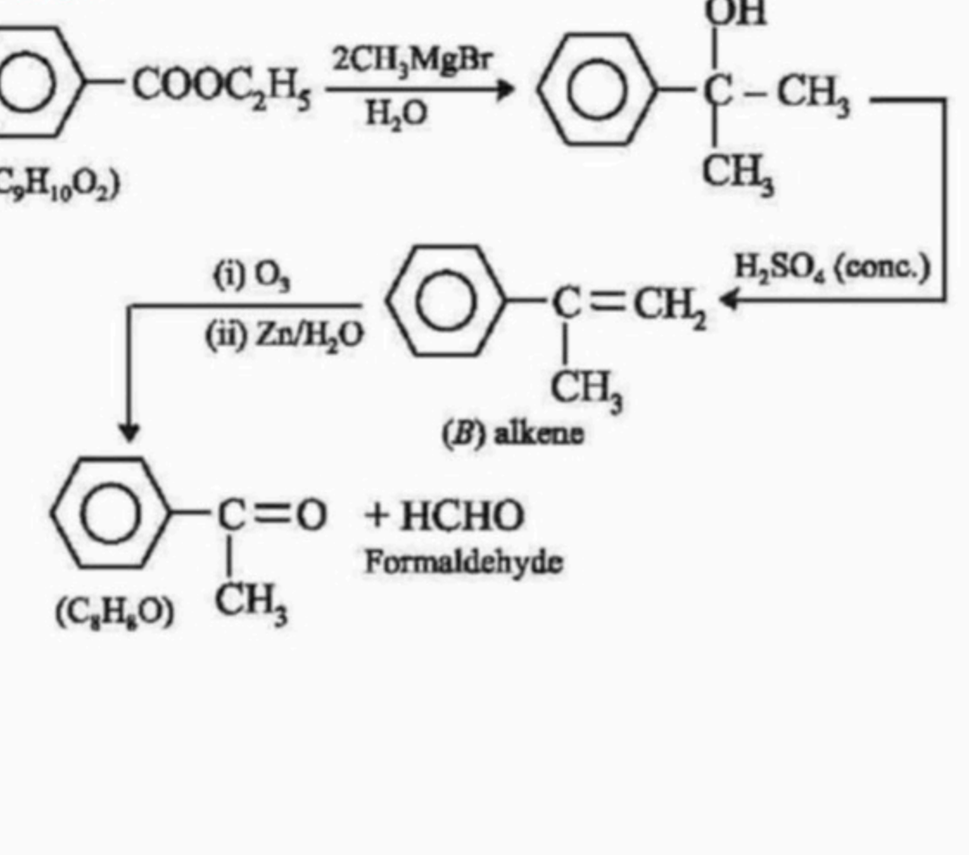
17. (d) :



18. (a) : $2Au + 4CN^- + H_2O + \frac{1}{2}O_2 \rightarrow \underset{(X)}{2[Au(CN)_2]^-} + 2OH^-$

$2[Au(CN)_2]^- + Zn \rightarrow \underset{(Y)}{[Zn(CN)_4]^{2-}} + 2Au$

19. (a) :



20. (a) :

21. (0.94) : Suppose x g of each gas is present.
Number of moles of $H_2 = x/2$
Number of moles of $C_2H_6 = x/30$
Mole fraction of $H_2 = 15/16$
Mole fraction of $C_2H_6 = 1/16$
Pressure exerted is directly proportional to mole fraction.
$\therefore$ Fraction of total pressure exerted by $H_2 = 15/16 = 0.94$

22. (71.34) :
The redox changes during electrolysis of $SnCl_2$ are,
Anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$
Cathode : $Sn^{2+} + 2e^- \longrightarrow Sn$
Also, Cl_2 formed at anode reacts with $SnCl_2$ to give $SnCl_4$.
$SnCl_2 + Cl_2 \longrightarrow SnCl_4$
Now, eq. of $SnCl_2$ lost during electrolysis = Eq. of Cl_2 formed during electrolysis = Eq. of Sn formed during electrolysis $= \dfrac{0.119}{119/2} = 2 \times 10^{-3}$
$\therefore$ Eq. of $SnCl_4$ formed $= 2 \times 10^{-3}$
Total loss in eq. of $SnCl_2$ during complete course
= Eq. of $SnCl_2$ lost during electrolysis + Eq. of $SnCl_2$ lost during reaction with Cl_2
$= 2 \times 10^{-3} + 2 \times 10^{-3} = 4 \times 10^{-3}$
Initial eq. of $SnCl_2 = \dfrac{19}{190/2} = 2 \times 10^{-1}$
$\therefore$ Eq. of $SnCl_2$ left in solution
$= 2 \times 10^{-1} - 4 \times 10^{-3} = 0.196$
$\therefore \quad \dfrac{\text{Mass of } SnCl_2 \text{ left}}{\text{Mass of } SnCl_4 \text{ formed}} = \dfrac{0.196 \times (190/2)}{0.002 \times (261/2)} = 71.34$

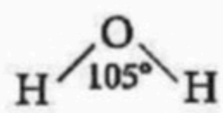
23. (3.39) : For benzene, $K_f = \dfrac{MRT_f^2}{1000\,\Delta H_{fus}\ (\text{cal/ g})}$
$= \dfrac{78 \times 8.314 \times (278.4)^2}{1000 \times 10.042 \times 10^3}$
$= 5.0\ \text{K molality}^{-1}$
Also, $\Delta T = 278.4 - 277.4 = 1.0$
For acetic acid in benzene,

	$2CH_3COOH$	$\rightleftharpoons$	$(CH_3COOH)_2$
Before association :	C		0
After association :	$C(1-\alpha)$		$(C\alpha)/2$

$\therefore \quad K_c = \dfrac{C\alpha/2}{C^2(1-\alpha)^2}$ ...(i)
where, α is degree of association.
Also, $\Delta T = K_f \times \text{molality} \times [1 - (\alpha/2)]$ ...(ii)
$\left(\because \text{ Total particles at equilibrium} = 1 - \alpha + \dfrac{\alpha}{2} = 1 - \dfrac{\alpha}{2}\right)$
Given, mole fraction of acetic acid $= 0.02 = \dfrac{n}{n+N}$
$\therefore$ Mole fraction of benzene $= 0.98 = \dfrac{N}{n+N}$
Now, molality of acetic acid in benzene $= \dfrac{w \times 1000}{m \times W}$
$= \dfrac{w \times 1000}{m \times \frac{W}{M} \times M} = \dfrac{n \times 1000}{N \times M} = \dfrac{0.02 \times 1000}{0.98 \times 78} = 0.262$ m
$\therefore$ From eqn. (ii),
$1 = 5 \times 0.262 \times (1 - \alpha/2)$
$\therefore \quad \alpha = 0.48$
From eqn. (i), (Assuming, molarity = molality), we get
$K_c = \dfrac{0.262 \times 0.48}{2 \times (0.262)^2 \times (1 - 0.48)^2} = 3.39$

24. (3.09) : Photon energy liberated from $He^+ = hc/\lambda$
In first line of Lyman series, $E = hcR_H \times Z^2\left(\dfrac{1}{1^2} - \dfrac{1}{2^2}\right)$
$= 6.626 \times 10^{-27} \times 3.0 \times 10^{10} \times 109678 \times 2^2 \times [3/4]$
$= 6.54 \times 10^{-11}$ erg
This energy is used in liberating electron from H-atom from ground state and therefore,
$6.54 \times 10^{-11} = E_1$ of H + *K.E.* of electron given out
$\because \quad K.E. = 6.54 \times 10^{-11} - E_1$ of H
$= 6.54 \times 10^{-11} - 13.6 \times 1.602 \times 10^{-12}$
$= 6.54 \times 10^{-11} - 2.178 \times 10^{-11}$
$= 4.362 \times 10^{-11}$ erg
$\therefore \quad \left(\dfrac{1}{2}\right)mu^2 = 4.362 \times 10^{-11}$
or $\quad u^2 = \dfrac{4.362 \times 10^{-11} \times 2}{9.108 \times 10^{-28}}$
$\therefore \quad u = 3.09 \times 10^8\ \text{cm sec}^{-1}$

25. (3.23) : Given bond angle in water molecule is 105°.



$\mu_{(H_2O)} = \sqrt{\mu_{OH}^2 + \mu_{OH}^2 + 2\mu^2 \cos(105°)}$
Since, H_2O has two vectors of O—H bond acting at 105°. Let dipole moment of O—H bond be '*a*'.
$\therefore \quad 1.85 = \sqrt{2a^2(1 + \cos 105°)}$
or *a*, *i.e.*, $\mu_{O-H} = 1.52$ debye $= 1.52 \times 10^{-18}$ esu cm
Now, $\mu_{O-H} = \delta \times d$
$\therefore \quad 1.52 \times 10^{-18} = \delta \times 0.94 \times 10^{-8}$
$\therefore \quad \delta = 1.617 \times 10^{-10}$ esu
Since, O acquires 2δ charge *i.e.*, one δ charge from each bond and thus, charge on O-atom
$= 2\delta = 2 \times 1.617 \times 10^{-10} = 3.23 \times 10^{-10}$ esu-cm.

JEE Main

NUMERICAL VALUE TYPE QUESTIONS

1. A plant virus is found to consist of uniform cylindrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is 0.75 cm^3/g. If the virus is considered to be a single particle and its molar mass is $x \times 10^7$ g mol^{-1} then the value of x is _____.

2. A solution containing 4.5 mmol and 15 mmol of $Cr_2O_7^{2-}$ and Cr^{3+} respectively and shows a pH of 2.0. The potential of half reaction is _____. (Standard potential of the reaction is 1.33 V.)

3. 0.4 g of an organic compound was Kjeldahlised and ammonia evolved was absorbed into 50 mL of N/2 H_2SO_4. The residual acid solution was diluted with water to make the volume 150 mL. 20 mL of this solution required 31 mL of N/20 NaOH solution for complete neutralisation. The percentage of nitrogen in the compound is _____.

4. The standard enthalpy of the decomposition of N_2O_4 to NO_2 is 58.04 kJ and standard entropy of this reaction is 176.7 J/K. Therefore, the standard free energy change (in kJ) for this reaction at 25°C is _____.

5. A compound with molecular formula, $C_4H_{10}O_3$ is converted by the action of acetyl chloride to a compound with molar mass 190. The original compound consists of —OH groups _____.

6. The conductivity of a saturated solution of CaF_2 is 3.86×10^{-5} S cm^{-1} and that of water used for solution is 0.15×10^{-5} at 291 K. If ionic conductances of Ca^{2+} and F^- at infinite dilution are 51.0 and 47.0 S cm^2 eq^{-1} then the solubility of CaF_2 in solution is $x \times 10^{-2}$ g L^{-1}. The value of x is _____.

7. *n*-Butane is produced by monobromination of ethane followed by the Wurtz reaction if the bromination takes place with 90% yield and the Wurtz reaction with 85% yield. Then volume (in litres) of ethane at NTP required to produce 55 g of *n*-butane is _____.

8. Iron sulphide is heated in air to form *A*, an oxide of sulphur. *A* is dissolved in water to give an acid. The basicity of this acid is _____.

9. The gaseous reaction, $A_{(g)} \longrightarrow 2B_{(g)} + C_{(g)}$ is found to be first order. If the reaction is started with $p_A = 90$ mm Hg, the total pressure after 10 minutes is found to be 180 mm Hg. The rate constant of the reaction is $x \times 10^{-3}$ s^{-1}. The value of x is _____.

10. A metal complex having composition $[Cr(NH_3)_4Cl_2Br]$ has been isolated in two forms (*A*) and (*B*). The form (*A*) reacts with $AgNO_3$ to give a white precipitate which is readily soluble in dilute aqueous ammonia, whereas (*B*) gives a pale yellow precipitate which is soluble in concentrated ammonia. Magnetic moments (spin-only value) of both the complexes will be _____.

SOLUTIONS

1. **(7.1) :** Radius of the cylindrical particle,

$$r = \frac{150 \times 10^{-8}}{2} \text{ cm} = 75 \times 10^{-8} \text{ cm}$$

Length, $l = 5000 \times 10^{-8}$ cm

$\therefore$ Volume of particle, $V = \pi r^2 l$

$= 3.14 \times (7.5 \times 10^{-7})^2 \times 5.0 \times 10^{-5} = 8.83 \times 10^{-17}$ cm^3

Mass of one cylindrical particle,

$$m = \frac{V}{d} = \frac{8.83 \times 10^{-17} \text{ cm}^3}{0.75 \text{ cm}^3/\text{g}} = 1.18 \times 10^{-16} \text{ g}$$

Molar mass of the particle, $M = m \times N_A$ (since, virus is considered to be a single particle.)

$= (1.18 \times 10^{-16}\text{g})\ (6.023 \times 10^{23}) = 7.1 \times 10^7$ g mol^{-1}

2. **(1.067) :** Cell reaction may be written as :

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O;\ n = 6$$

Now, applying Nernst equation,

$$E = E^\circ - \frac{0.0591}{n} \log \frac{[Cr^{3+}]^2}{[Cr_2O_7^{2-}][H^+]^{14}}$$

$[Cr^{3+}] = 15$ mmol $= 15 \times 10^{-3}$ M

$[Cr_2O_7^{2-}] = 4.5$ mmol $= 4.5 \times 10^{-3}$ M

pH $= -\log [H^+] = 2$; Thus, $[H^+] = 10^{-2}$

$$E = 1.33 - \frac{0.0591}{6}\log\frac{(15\times10^{-3})^2}{(4.5\times10^{-3})(10^{-2})^{14}}$$

$$E = 1.33 - \frac{0.0591}{6}\log(5\times10^{26}) = 1.067\ \text{V}$$

3. (46.81) : Let the volume of N/2 H_2SO_4 left unused by ammonia = V mL

V mL of this solution was diluted with water upto 150 mL. 20 mL of dilute solution is neutralising 31 mL of N/20 NaOH. Normality of diluted solution can be calculated as,

$N_1V_1 = N_2V_2$

$$\text{or}\quad N_1\times20 = \frac{\text{N}}{20}\times31\ ;\ \therefore N_1 = \frac{\text{N}}{20}\times31\times\frac{1}{20} = \frac{31}{400}\times\text{N}$$

Normality of 150 mL of acid solution = $\frac{31\times\text{N}}{400}$

V mL of N/2 H_2SO_4 can be calculated as,

$$N_1V_1 = N_2V_2 \text{ or } V\times\frac{\text{N}}{2} = \frac{31\times\text{N}}{400}\times150$$

$$\therefore\quad V = \frac{31\times150\times2}{400} = 23.25\ \text{mL}$$

Thus, volume of N/2 H_2SO_4 left = 23.25 mL

Thus, volume of acid used to neutralised NH_3 = 50 – 23.25 = 26.75 mL of N/2 normality

This will be volume of NH_3 liberated with normality N/2.

$$\%\ \text{N} = \frac{1.4\times V\times N_1}{W} = \frac{1.4\times26.75\times1}{0.4\times2} = 46.81\%$$

4. (5.39) : Standard enthalpy of decomposition (ΔH) = 58.04 kJ

Standard entropy (ΔS) = 176.7 J/K = 176.7×10^{-3} kJ/K and temperature (T) = 25°C = 298 K

Change in free energy (ΔG) = $\Delta H - T\Delta S$

= $58.04 - 298\times(176.7\times10^{-3}) = 58.04 - 52.65 = 5.39$ kJ

5. (2) : In acetylation, replacement of –H of –OH occurs by CH_3CO- group.

$$-\text{OH} + \text{Cl}-\overset{\overset{\text{O}}{\|}}{\text{C}}-\text{CH}_3 \longrightarrow -\text{OCOCH}_3 + \text{HCl}$$

i.e., H-atom of mass 1 u is lost and an acetyl group of mass 43 u is added. Net gain, 43 – 1 = 42 for every acetyl group introduced.

Mass difference of final to original = 190 – 106 = 84

Therefore, number of –OH groups in the original compound = 84/42 = 2

6. (1.99) : κ_{CaF_2} + water = 3.86×10^{-5}

$\kappa_{water} = 0.15\times10^{-5}$

$\kappa_{CaF_2} = 3.86\times10^{-5} - 0.15\times10^{-5} = 3.71\times10^{-5}\ \text{S cm}^{-1}$

$\Lambda^\circ_{CaF_2} = \lambda^\circ_{Ca^{2+}} + 2\lambda^\circ_{F^-} = 51.0 + 2(47.0) = 145\ \text{S cm}^2\ \text{mol}^{-1}$

Solubility of CaF_2

$$= \frac{\kappa\times1000}{\Lambda^\circ_m} = \frac{3.71\times10^{-5}\times1000}{145}\ \text{mol L}^{-1}$$

(Mol. wt. of CaF_2 = 78)

$$= \frac{3.71\times10^{-5}\times1000}{145}\times78\ \text{g L}^{-1} = 1.99\times10^{-2}\ \text{g L}^{-1}$$

7. (55.5): $\underset{30\ \text{g}}{C_2H_6} + Br_2 \longrightarrow \underset{109\ \text{g}}{C_2H_5Br} + HBr$

$$\underset{2\times109\ \text{g}}{2C_2H_5Br} + 2Na \longrightarrow \underset{58\ \text{g}}{C_4H_{10}} + 2NaBr$$

55 g butane will be produced from $= \frac{2\times109}{58}\times55$ g ethyl bromide.

As the yield is 85% , the actual ethyl bromide required

$$= \frac{2\times109}{58}\times55\times\frac{100}{85} = 243.2\ \text{g}$$

243.2 g of ethyl bromide will be produced from

$$= \frac{30}{109}\times243.2 = 66.93\ \text{g ethane}$$

As the yield is 90%, the actual ethane required

$$= \frac{100}{90}\times66.93 = 74.37\ \text{g}$$

Volume of the ethane at NTP $= \frac{74.37}{30}\times22.4 = 55.5$ L

8. (2) : $4FeS_2 + 11O_2 \longrightarrow \underset{(A)}{2Fe_2O_3} + 8SO_2$

$$\underset{(A)}{SO_2} + H_2O \longrightarrow \underset{(\text{Acid})}{H_2SO_3} \rightleftharpoons 2H^+ + SO_3^{2-}$$

Hence, basicity of acid, H_2SO_3 is two.

9. (1.15) :

	$A_{(g)}$	$\rightarrow$	$2B_{(g)}$	+	$C_{(g)}$
Initial pressure :	p_A		0		0
Final pressure :	$p_A - p$		$2p$		p

Total pressure = $p_A - p + 2p + p$ = 180 mm Hg

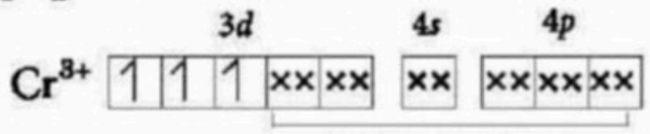
p_A = 90 mm Hg; Then, $p_A + 2p = 180$

$$p = \frac{180-90}{2} = 45\ \text{mm Hg}$$

$$k = \frac{2.303}{t}\log\frac{p_A}{p_A - p} = \frac{2.303}{10\times60}\log\frac{90}{45} = 1.15\times10^{-3}\ \text{s}^{-1}$$

10. (3.87) : Since (A) when treated with $AgNO_3$ forms a white ppt (of AgCl) which is readily soluble in dil. $NH_{3(aq)}$ so, (A) has atleast one Cl^- ion (ionisable chlorine atom). Moreover, since the coordination number of chromium is 6 so, the formula of the compound (A) is $[Cr(NH_3)_4BrCl]Cl$.

Since, compound (B) when treated with $AgNO_3$ forms a pale yellow ppt (of AgBr) soluble in concentrated $NH_{3(aq)}$ so, (B) has a Br^- (ionisable bromine atom) in the ionisation sphere. So, the formula of compound (B) is $[Cr(NH_3)_4Cl_2]Br$. Cr in both A and B is in +3 state *i.e.*, Cr^{3+}.



In both cases d^2sp^3 hybridisation occurs.

Spin magnetic moment of A or B :

In both cases n = 3 (n = number of unpaired electrons)

$\therefore$ Spin magnetic moment = $\sqrt{n(n+2)}$

= $\sqrt{3(3+2)} = \sqrt{3\times5} = \sqrt{15}$ or 3.87 B.M.

Get Ready for NEET

PRACTICE PAPER 2020

1. Which of the following ions does not exist?
(a) $[SiCl_6]^{2-}$ (b) $[GeF_6]^{2-}$
(c) $[CCl_6]^{2-}$ (d) $[SnCl_6]^{2-}$

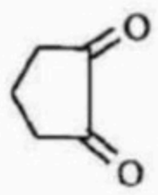
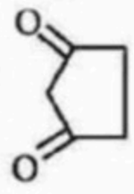
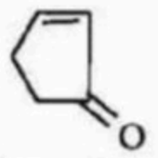
2. In which of the following reactions there is no change in oxidation number?
(a) $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$
(b) $2Na + O_2 \rightarrow Na_2O_2$
(c) $Na_2O + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
(d) $4KClO_3 \rightarrow 3KClO_4 + KCl$

3. A compound has a haemoglobin-like structure. It has one Fe atom. It contains 4.6% of Fe. The approximate molecular mass of the compound is
(a) 1100 g mol^{-1} (b) 1217.4 g mol^{-1}
(c) 1428.8 g mol^{-1} (d) 1612.5 g mol^{-1}

4. Two elements whose electronegativities are 1.2 and 3.0, the bond formed between them would be
(a) ionic (b) covalent
(c) coordinate (d) metallic.

5. White lung cancer is caused by
(a) paper (b) asbestos
(c) silica (d) none of these.

6. Periodic oxidation of 1,2-cyclopentanediol is

(a) 
(b) 
(c) 
(d) 

7. Teflon, styron and neoprene are all
(a) co-polymers
(b) condensation polymers
(c) homopolymers (d) monomers.

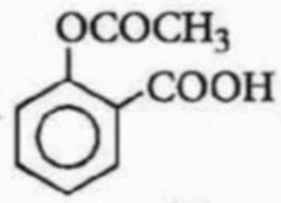
8. The e.m.f. of the cell,
$Zn \mid Zn^{2+}(0.01\ M) \parallel Fe^{2+}(0.001\ M) \mid Fe$
at 298 K is 0.2905 V. The value of the equilibrium constant for the cell reaction is
(a) $\frac{0.32}{e^{0.0295}}$ (b) $\frac{0.32}{10^{0.0295}}$
(c) $\frac{0.26}{10^{0.0295}}$ (d) $\frac{0.32}{10^{0.0591}}$

9. For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both positive, If T_e is the temperature at equilibrium, the reaction would be spontaneous when
(a) $T = T_e$ (b) $T_e > T$ (c) $T > T_e$ (d) $T_e = 5T$

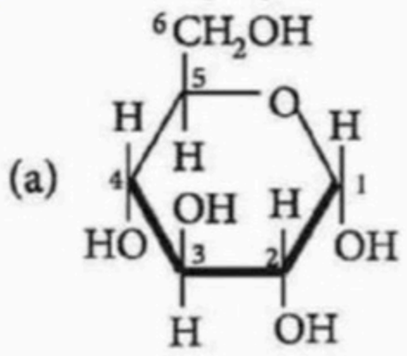
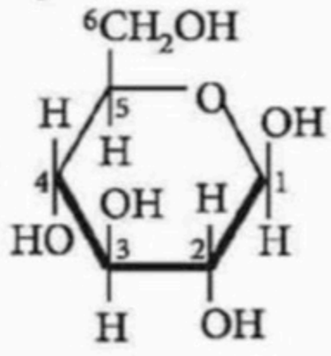
10. The degeneracy of hydrogen atom that has energy equal to $-\frac{R_H}{9}$ (where, R_H is Rydberg constant) is
(a) 4 (b) 6 (c) 9 (d) 12

11. An ideal gas at pressure P_0 in a vessel. If the masses of all the molecules are halved and their *rms* speeds doubled, the resulting pressure P will be
(a) $4P_0$ (b) $2P_0$ (c) P_0 (d) $P_0/2$

12. Among CaH_2, NH_3, NaH and B_2H_6 which are covalent hydrides?
(a) NH_3 and B_2H_6 (b) NaH and CaH_2
(c) NaH and NH_3 (d) CaH_2 and B_2H_6

13. The compound  is used as a/an
(a) antiseptic (b) antibiotic
(c) analgesic (d) pesticide.

14. Haworth's projection of α-D-glucose is

(a) 
(b) 
(c) both of these (d) none of these.

15. Two nodal planes are present in
(a) π^*2p_x (b) $\sigma2p_z$ (c) $\pi2p_x$ (d) $\pi2p_y$

16. Anti-Markovnikov's addition of HBr is not observed in
(a) propene (b) 1-butene
(c) but-2-ene (d) pent-2-ene.

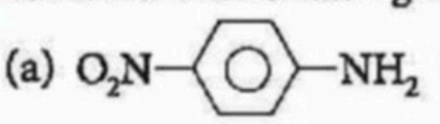
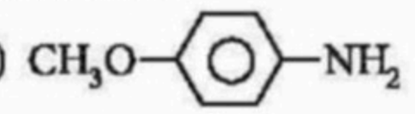
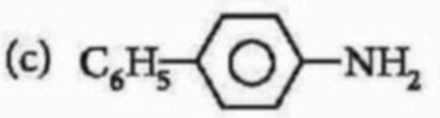
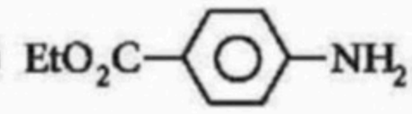
17. K_p/K_c for the reaction,
$CO + 1/2O_2 \rightleftharpoons CO_2$ is
(a) $\sqrt{RT}$ (b) $\frac{\sqrt{RT}}{2}$
(c) 1 (d) none of these.

18. Which of the following xenon compounds has the same number of lone pairs as in I_3^-?
(a) XeO_4 (b) XeF_4 (c) XeF_2 (d) XeO_3

19. For a second order reaction in which both the reactants have equal initial concentration, the time taken for 20% completion of reaction is 500 seconds. What will be the time taken for 60% completion of the reaction?
(a) 500 sec (b) 1000 sec
(c) 3000 sec (d) 1500 sec

20. Arrange (I) Ce^{3+}, (II) La^{3+} (III) Pm^{3+} and (IV) Yb^{3+} in increasing order of their ionic radii.
(a) IV < III < I < II (b) I < IV < III < II
(c) IV < III < II < I (d) III < II < I < IV

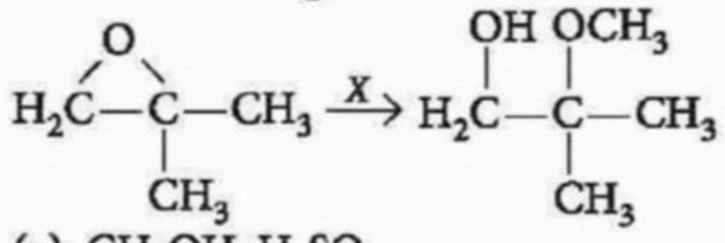
21. The correct order of the packing efficiency in different types of unit cells is
(a) *fcc* < *bcc* < simple cubic
(b) *fcc* > *bcc* > simple cubic
(c) *fcc* < *bcc* > simple cubic
(d) *bcc* < *fcc* > simple cubic.

22. Which of the following is least basic?
(a)  (b) 
(c)  (d) 

23. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in water has a freezing point depression of 0.0054 °C. If K_f for water is 1.80 °C m^{-1}, the correct formulation for the above molecule is
(a) $[Pt(NH_3)_4Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl_2]Cl_2$
(c) $[Pt(NH_3)_4Cl]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

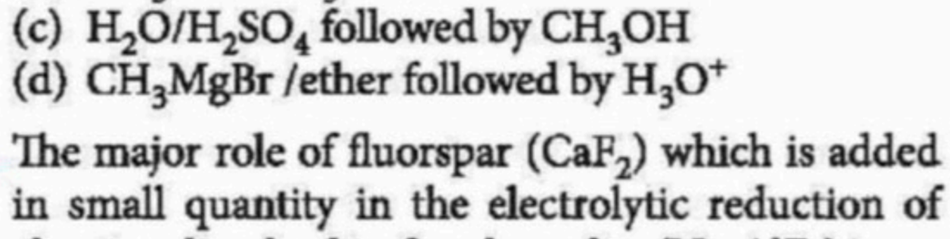
24. Anhydrous mixture of KF and HF contains which type of ions?
(a) K^+, H^+, F^- (b) $(KF)^+ (HF)^-$
(c) KH^+, F^- (d) K^+, HF_2^-

25. Gold numbers of protective colloids *A*, *B*, *C* and *D* are 0.50, 0.01, 0.10 and 0.005 respectively. The correct order of their protective powers is
(a) $D < A < C < B$ (b) $C < B < D < A$
(c) $A < C < B < D$ (d) $B < D < A < C$

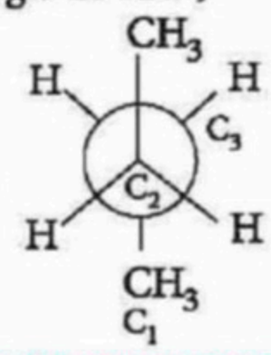
26. For the following conversion, *X* will be

(a) CH_3OH, H_2SO_4
(b) $CH_3OH, CH_3O^-Na^+$
(c) H_2O/H_2SO_4 followed by CH_3OH
(d) CH_3MgBr /ether followed by H_3O^+

27. The major role of fluorspar (CaF_2) which is added in small quantity in the electrolytic reduction of alumina dissolved in fused cryolite (Na_3AlF_6) is
1. as a catalyst
2. to make the fused mixture very conducting
3. to lower the fusion temperature
4. to decrease the rate of oxidation of carbon at the anode.

(a) 2, 3 (b) 1, 2 (c) 2, 3, 4 (d) 3, 4

28. The final product *D* in the given sequence of reactions is

(a) benzene (b) tetralin
(c) decalin (d) naphthalene.

29. In the given conformation C_2 is rotated about $C_2—C_3$ bond anticlockwise by an angle of 120°, then the conformation obtained is
(a) fully eclipsed conformation
(b) partially eclipsed conformation
(c) gauche conformation
(d) staggered conformation.



Solution Senders of Chemistry Musing

Set - 80

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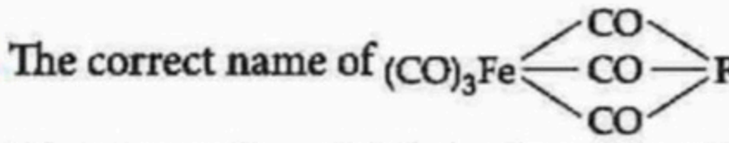
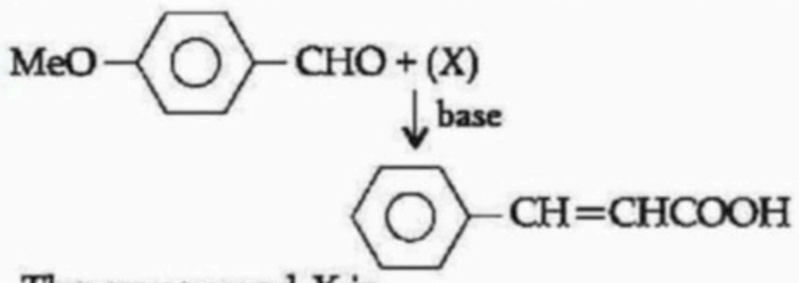
30. The correct name of  is

(a) tri-μ-carbonyl*bis*(tricarbonyl)iron(0)
(b) hexacarbonyl iron(III)tricarbonylferrate(0)
(c) tricarbonyl iron(0) tricarbonyliron(0) tricarbonyl
(d) nonacarbonyl iron.

31. The ionic radii of N^{3-}, O^{2-}, F^-, Na^+ follow the order
(a) $N^{3-} > O^{2-} > F^- > Na^+$
(b) $N^{3-} > Na^+ > O^{2-} > F^-$
(c) $Na^+ > O^{2-} > N^{3-} > F^-$
(d) $O^{2-} > F^- > Na^+ > N^{3-}$

32. 5 g sample of bleaching powder is treated with excess acetic acid and KI solution. The liberated I_2 required 50 mL of N/10 hypo. The per cent of available chlorine in the sample is
(a) 3.55 (b) 7.0 (c) 35.5 (d) 28.2

33. 

The compound *X* is
(a) CH_3COOH (b) $BrCH_2COOH$
(c) $(CH_3CO)_2O$ (d) OHC—COOH

34. On passing *I* ampere of current for time *t* sec through 1 litre of 2 M $CuSO_4$ solution (atomic weight of Cu = 63.5), the amount *m* of Cu (in g) deposited on cathode will be

(a) $m = \frac{It}{(63.5 \times 96500)}$ (b) $m = \frac{It}{(31.25 \times 96500)}$

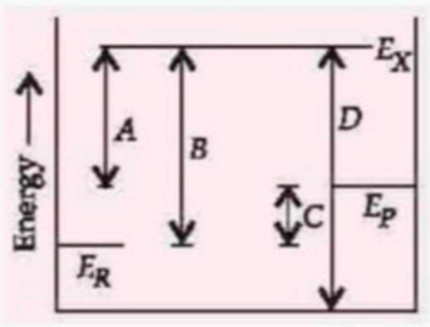
(c) $m = \frac{I \times 96500}{(31.25 \times t)}$ (d) $m = \frac{31.75 \times I \times t}{96500}$

35. Which of the following structures permits *cis-trans* isomerism?
(a) $X_2C=CY_2$ (b) $XYC=CZ_2$
(c) $X_2C=CXY$ (d) $XYC=CXZ$

36. For the change, $C_{diamond} \rightarrow C_{graphite}$; $\Delta H = -1.89$ kJ, if 6 g of diamond and 6 g of graphite are separately burnt to yield CO_2, the heat liberated in first case is
(a) less than in the second case by 1.89 kJ
(b) less than in the second case by 11.34 kJ
(c) less than in the second case by 14.34 kJ
(d) more than in the second case by 0.945 kJ.

37. 0.85% aqueous solution of $NaNO_3$ is apparently 90% dissociated at 27°C. The osmotic pressure will be ($R = 0.082$ atm K^{-1} mol^{-1})
(a) 2.210 atm (b) 4.674 atm
(c) 3.049 atm (d) 5.012 atm.

38. In the accompanied diagram, E_R, E_P and E_X represent the energy of the reactants, products and activated complex respectively. Which of the following is the activation energy for the backward reaction?



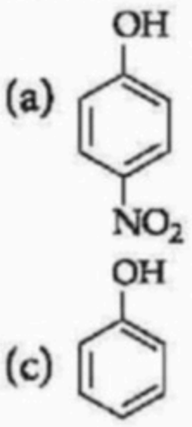
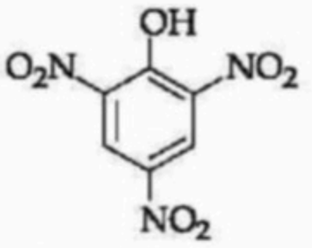
(a) *A* (b) *B* (c) *C* (d) *D*

39. Which of the following organometallic compounds is σ- and π-bonded?
(a) $[Fe(\eta^5\text{-}C_5H_5)_2]$ (b) $[PtCl_3(\eta^2\text{-}C_2H_4)]$
(c) $[Co(CO)_5NH_3]^{2+}$ (d) $Al(CH_3)_3$

40. A cylinder contains nitrogen gas and a small amount of liquid water at a temperature 25°C. (The vapour pressure of water is 23.8 mm Hg). The total pressure is 600 mm Hg. A piston is pushed into the cylinder until the volume is halved. What is the final total pressure?
(a) 1176.2 atm (b) 1.55 atm
(c) 1152.4 atm (d) 1.98 atm

41. Which of the following ions has correct decreasing order *X* – O bond length? (where *X* is the central atom.)
(a) ClO_4^-, SO_4^{2-}, PO_4^{3-}, SiO_4^{4-}
(b) SiO_4^{4-}, PO_4^{3-}, SO_4^{2-}, ClO_4^-
(c) SiO_4^{4-}, PO_4^{3-}, ClO_4^-, SO_4^{2-}
(d) SiO_4^{4-}, SO_4^{2-}, PO_4^{3-}, ClO_4^-

42. Which of the following derivatives of phenol is most likely to give effervescence with dilute solution of sodium bicarbonate ?

(a) 
(b) 
(c)
(d)

43. The correct sequence of decreasing number of π-bonds in the structures of H_2SO_3, H_2SO_4 and $H_2S_2O_7$ is
(a) $H_2SO_3 > H_2SO_4 > H_2S_2O_7$
(b) $H_2SO_4 > H_2S_2O_7 > H_2SO_3$
(c) $H_2S_2O_7 > H_2SO_4 > H_2SO_3$
(d) $H_2S_2O_7 > H_2SO_3 > H_2SO_4$

44. The number of radial nodes and angular nodes for *d*-orbital can be represented as

(a) $(n-2)$ radial nodes + 1 angular node
$= (n-1)$ total nodes

(b) $(n-1)$ radial nodes + 1 angular node
$= (n-1)$ total nodes

(c) $(n-3)$ radial nodes + 2 angular nodes
$= (n-l-1)$ total nodes

(d) $(n-3)$ radial nodes + 2 angular nodes
$= (n-1)$ total nodes.

45. The solubility order for alkali metals fluoride in water is

(a) LiF < RbF < KF < NaF

(b) RbF < KF < NaF < LiF

(c) LiF > NaF > KF > RbF

(d) LiF < NaF < KF < RbF

SOLUTIONS

1. (c) : Carbon cannot expand its valency beyond 4 due to unavailability of *d*-orbitals.

2. (c) : $\overset{+1\ -2}{Na_2O} + \overset{+1\ +6-2}{H_2SO_4} \longrightarrow \overset{+1\ +6-2}{Na_2SO_4} + \overset{+1\ -2}{H_2O}$

3. (b): 1 g-atom of Fe (56 g Fe) is present in 1 mole of the compound.

As 4.6 g of Fe is present in 100 g of the compound.

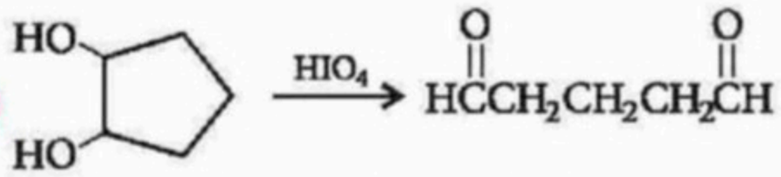
$\therefore$ 56 g of Fe will be present in $\frac{100}{4.6} \times 56$ g

$= 1217.4$ g of the compound

4. (a) : Electronegativity difference = 3.0 – 1.2 = 1.8. If the electronegativity difference is more than 1.7, then bond will have ionic character. If the electronegativity difference is between 0.4 to 1.7, then bond will have polar covalent character and if the electronegativity difference is less than 0.4. Then bond will have non-polar covalent character.

5. (b)

6. (d) :



7. (c) : Teflon (polytetrafluoroethylene), styron (polystyrene) and neoprene (polychloroprene) all are homopolymers.

8. (b) : $Zn + Fe^{2+} \longrightarrow Fe + Zn^{2+}$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{n}\log\frac{[Zn^{2+}]}{[Fe^{2+}]}$$

Given, $E_{cell} = 0.2905$

$$0.2905 = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{0.01}{0.001}$$

or, $E^\circ_{cell} = 0.2905 + 0.0295 \log 10$

$= 0.2905 + 0.0295 = 0.32$ V $\quad (\because \log 10 = 1)$

$$E^\circ_{cell} = \frac{0.0591}{n}\log K_{eq} \quad (\because E_{cell} = 0 \text{ at equilibrium})$$

or $0.32 = \frac{0.0591}{2}\log K_{eq} \quad \therefore K_{eq} = 10^{0.32/0.0295}$

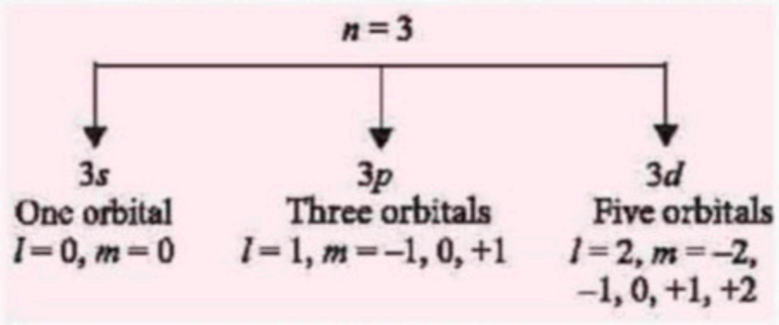
9. (c) : $\Delta G = \Delta H - T\Delta S$. At equilibrium, $\Delta G = 0$. Also, ΔG should be negative for a spontaneous reaction. So, $T > T_e$ in order to make ΔG negative, because both ΔH and ΔS are positive.

10. (c) : Energy in H atom $\frac{-R_H}{n^2}$

But, Given that, $E = -\frac{R_H}{9}$

$\therefore \quad n^2 = 9 \quad \Rightarrow \quad n = 3$

As here, $n = 3$ thus, there are three orbitals.



Degeneracy = 1 + 3 + 5 = 9

11. (b) : $u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}}$,

$u_1 = \sqrt{\frac{3P_0V}{M}}$ ...(i) $\qquad 2u_1 = \sqrt{\frac{3PV}{M/2}}$ ...(ii)

On dividing eqn. (i) by (ii),

$\therefore \quad \frac{1}{2} = \sqrt{\frac{P_0}{2P}} \quad$ or $\quad 2P = 4P_0, \quad \Rightarrow \quad P = 2P_0$

12. (a) : N and B belong to *p*-block and they form hydride by sharing of electrons *i.e.*, by forming covalent bond. So, they form covalent hydrides.

13. (c) : The given compound is acetylsalicylic acid, *i.e.* aspirin which is used as an analgesic.

14. (a)

15. (a) : π^*2p_x has two nodal planes perpendicular to each other.

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1. (d)	**2.** (d)	**3.** (b)	**4.** (d)	**5.** (c)
6. (d)	**7.** (d)	**8.** (c)	**9.** (b)	**10.** (c)
11. (b)	**12.** (a)	**13.** (a)	**14.** (a)	**15.** (c)
16. (b)	**17.** (d)	**18.** (a)	**19.** (c)	**20.** (c,d)
21. (a,c,d)	**22.** (b,c,d)	**23.** (a,c)	**24.** (3)	**25.** (6)
26. (3)	**27.** (a)	**28.** (c)	**29.** (a)	**30.** (d)

16. (c) : Anti-Markovnikov's addtion of HBr is observed only with unsymmetrical alkenes, *i.e.*, propene, 1-butene and pent-2-ene. Since 2-butene is symmetrical, therefore, anti-Markovnikov's addtion of HBr is not observed in this case.

17. (d) : $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_{2(g)}$

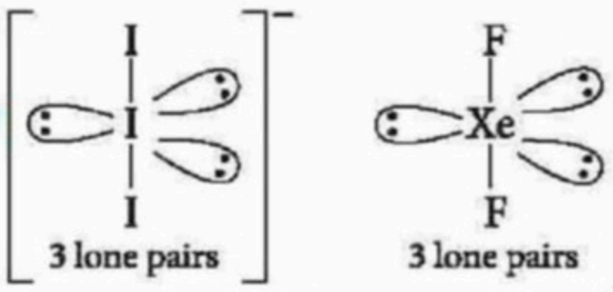
$$\Delta n = 1 - \left(1 + \frac{1}{2}\right) = -\frac{1}{2}$$

Since $K_p = K_c (RT)^{\Delta n}$

$\therefore \quad K_p = K_c (RT)^{-1/2}$

$$\frac{K_p}{K_c} = (RT)^{-1/2} \; ; \; \frac{K_p}{K_c} = \frac{1}{(RT)^{1/2}} = \frac{1}{\sqrt{RT}}$$

18. (c) :



19. (c) : For a second order reaction, $k = \frac{1}{t} \times \frac{x}{a(a-x)}$

Since $x = \frac{20}{100} = 0.2, \quad a = 1, t = 500$ s

$$k = \frac{1 \times 0.2}{500 \times 1(1-0.2)} = \frac{1}{500 \times 4} \quad \ldots(i)$$

When $x = 60\% \Rightarrow 60/100 = 0.6$

$$\text{then, } k = \frac{1}{t} \times \frac{0.6}{1(1-0.6)} \quad \ldots(ii)$$

Substituting the value of k from eq. (i) to eq. (ii)

$$\therefore \quad \frac{1}{500 \times 4} = \frac{1}{t} \times \frac{0.6}{0.4} \Rightarrow t = 3000 \text{ seconds}$$

20. (a) : Ionic radii decrease across lanthanide series due to lanthanide contraction. As all ions are in +3 O.S., ionic radii will follow the trend of atomic radii.

$\therefore \quad La^{3+} > Ce^{3+} > Pm^{3+} > Yb^{3+}$

21. (b) : Packing efficiency,
for *sc* unit cell = 52.4%
for *bcc* unit cell = 68%
for *fcc* unit cell = 74%
Thus, the order of packing efficiency is
fcc > *bcc* > simple cubic.

22. (a) : NO_2 is the most powerful electron withdrawing group and hence *p*-nitroaniline is the weakest base.

23. (b) : $\Delta T_f = iK_f \cdot m \Rightarrow i = \frac{\Delta T_f}{K_f \cdot m}$

$$i = \frac{0.0054}{1.80 \times 0.001} = 3$$

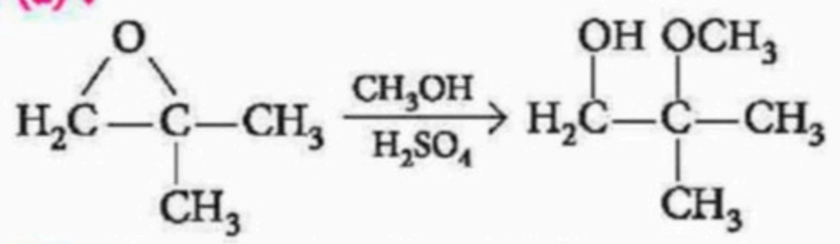
It means 3 ions are produced on dissociation hence, formula must be $[Pt(NH_3)_4Cl_2]Cl_2$.

24. (d) : $KF + HF \longrightarrow HF_2^- + K^+$

HF_2^- ion is formed due to hydrogen bonding.

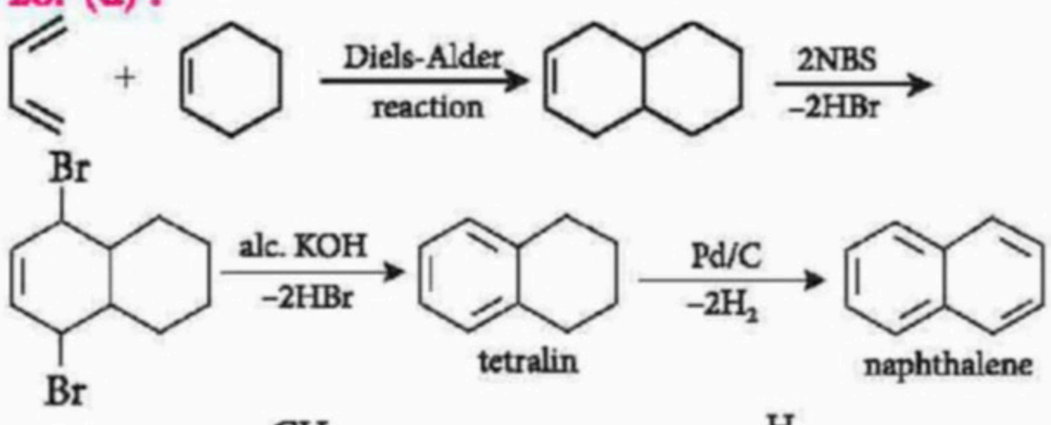
25. (c) : For a protective colloid, lesser the value of gold number, better is the protective power. Thus, the correct order of protective power is $A < C < B < D$.

26. (a) :

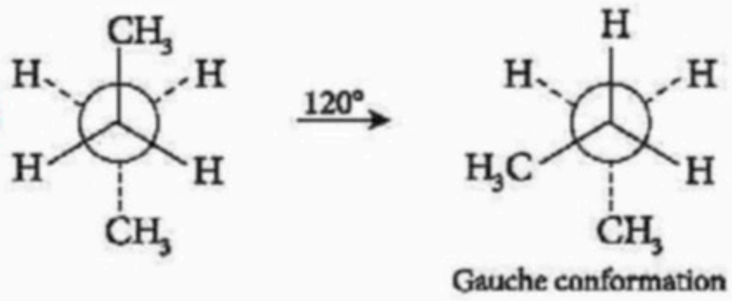


27. (a) : Fluorspar (CaF_2) is added in small quantity in the electrolytic reduction of alumina dissolved in fused cryolite (Na_3AlF_6) to make the fused mixture more conducting as alumina is a bad conductor of electricity and to lower the m.pt. of fused mixture as alumina has very high m.pt.

28. (d) :



29. (c) :



Gauche conformation

30. (a)

31. (a) : Ionic radii of isoelectronic species decrease with increase in nuclear charge. Thus, the order is

$$N^{3-} > O^{2-} > F^- > Na^+$$

32. (a) : meq. of bleaching powder = meq. of Cl_2
= meq. of hypo

$$\frac{w_{Cl_2}}{35.5} \times 1000 = 50 \times \frac{1}{10} \Rightarrow w_{Cl_2} = 0.1775 \text{ g}$$

$$\therefore \quad \text{Per cent } Cl_2 = \frac{0.1775}{5} \times 100 = 3.55\%$$

33. (c) : *X* is acetic anhydride. This is an example of Perkin's reaction.

34. (d) : According to Faraday's law of electrolysis,
$m \propto It$ or $m = ZIt$
where I = current, t = time and

$$Z = \frac{\text{Equivalent weight of substance}}{96500}$$

Eq. wt. of Cu $= \frac{63.5}{2}$ $(\because Cu^{2+} + 2e^- \rightarrow Cu)$

$\therefore \quad Z = \frac{63.5}{2 \times 96500}$

Now, $m = \frac{63.5 \times I \times t}{2 \times 96500} = \frac{31.75 \times I \times t}{96500}$

35. (d) : The conditions for geometrical isomerism in alkene is the two atoms or groups which are attached to the particular carbon atom must be different.

36. (d) : $C_D \rightarrow C_G$; $\Delta H = -1.89$ kJ ...(i)

$C_D + O_2 \rightarrow CO_2$; $\Delta H = -q_1$ kJ ...(ii)

$C_G + O_2 \rightarrow CO_2$; $\Delta H = -q_2$ kJ ...(iii)

By eqs, [(ii) – (iii)], we get

$C_D \rightarrow C_G$; $\Delta H = -q_1 + q_2$

$\therefore \quad -q_1 + q_2 = -1.89$

or $q_2 - q_1 = -1.89$ for 12 g $C_{D \rightarrow G}$

Thus, for 6 g $C_{D \rightarrow G}$

$q_2 - q_1 = \frac{-1.89}{2} = -0.945$ kJ

37. (b) : Molecular weight of $NaNO_3 = 85$ g mol^{-1}

Molarity $= \frac{W \times 1000}{M \times V} = \frac{0.85 \times 1000}{85 \times 100} = 0.1$ mol L^{-1}

$NaNO_3$ solution is 90% dissociated.

$NaNO_3 \rightleftharpoons Na^+ + NO_3^-$

1 – 0.9 0.9 0.9

van't Hoff factor, $i = 1 - 0.9 + 0.9 + 0.9 = 1.9$

$\therefore \quad \pi = 1.9 \times 0.1 \times 0.082 \times 300 = 4.674$ atm

38. (a) : For backward reaction, activation energy is the energy difference between product and activated complex.

39. (c) : Metal carbonyls are σ- as well as π-bonded.

40. (b) : $P_1 = 600 - 23.8 = 576.2$ mm of Hg; $V_2 = \frac{V_1}{2}$

According to Boyle's law, $P_1V_1 = P_2V_2$

$576.2 \times V_1 = P_2 \times \frac{V_1}{2}$

$P_2 = 1152.4$

The final total pressure = 1152.4 + 23.8 = 1176.2 mm

of Hg $= \frac{1176.2}{760} = 1.55$ atm

41. (b) : More will be the electronegativity of *X*, lesser will be the bond length of *X*—O bond.

42. (b) : 2, 4, 6-Trinitrophenol, which is highly acidic gives effervescence with dilute solution of $NaHCO_3$.

43. (c) : Number of π-bonds,

$H_2S_2O_7 = HO - \overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}} - O - \overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}} - OH$ (π bonds = 4)

$H_2SO_4 = HO - \overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}} - OH$ (π-bonds = 2)

$H_2SO_3 = HO - \overset{\overset{\bullet\bullet}{}}{\underset{\underset{O}{\|}}{S}} - OH$ (π-bond = 1)

44. (d) : For *d*-orbital, radial nodes = $(n - l - 1)$

$= (n - 2 - 1) = n - 3$, angular nodes $= l = 2$

and total number of nodes $= n - 1$

45. (d) : Higher the lattice enthalpy lower will be solubility *i.e.*, lattice enthalpy $\propto \frac{1}{\text{Solubility}}$

Since the lattice enthalpies of alkali metals follow the order Li > Na > K > Rb.

Hence, the correct order of solubility is

LiF < NaF < KF < RbF.

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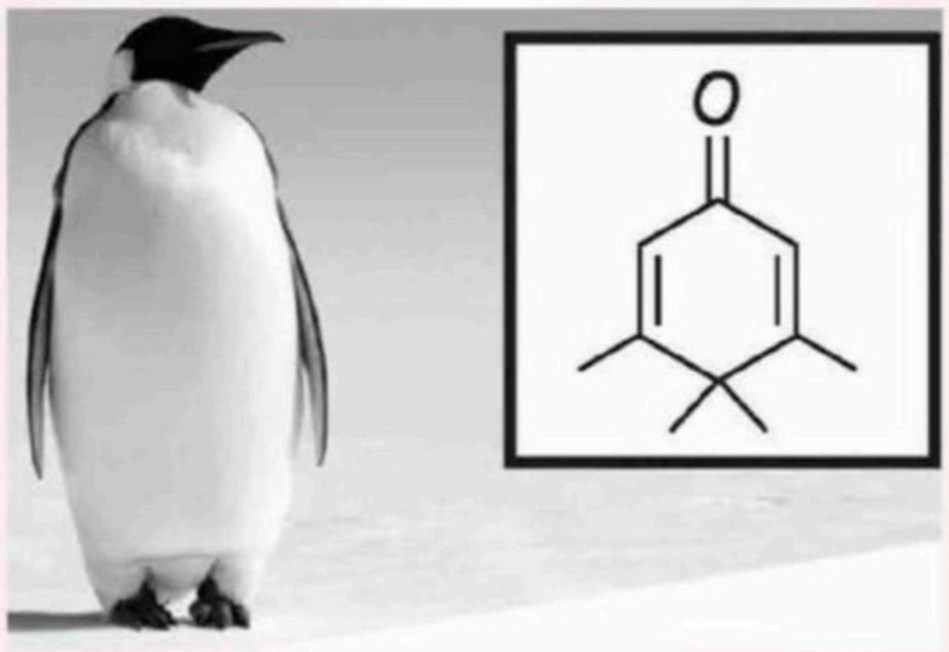
COMIC CAPSULE

Penguinone ($C_{10}H_{14}O$) is an organic compound and its name comes from the fact that it resembles a penguin.



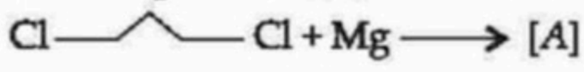
PRACTICE PAPER

BITSAT

Exam date: 16th to 25th May 2020

1. 2.0 g of oxygen contains number of atoms equal to that in
   (a) 4.0 g of sulphur (b) 7.0 g of nitrogen
   (c) 0.5 g of hydrogen (d) 2.3 g of sodium.

2. What is the product [*A*] in the following reaction?



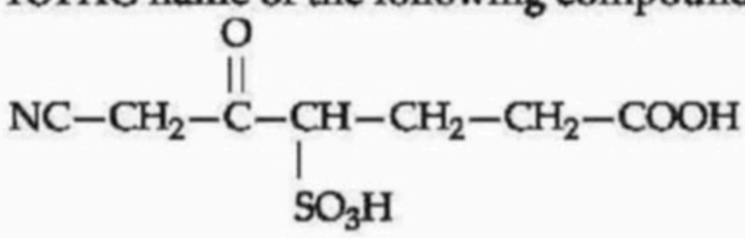
   (a) 
   (b) ClMg — MgCl
   (c) Both (a) and (b) (d) None of these

3. The isoelectric point of a colloidally dispersed material is the pH value at which
   (a) the dispersed phase migrate in an electric field
   (b) the dispersed phase does not migrate in an electric field
   (c) the dispersed phase has pH equal to 7
   (d) the dispersed phase has pH equal to zero.

4. The quantity of electricity needed to electrolyse completely 1 M solution of $CuSO_4$, $Bi_2(SO_4)_3$, $AlCl_3$ and $AgNO_3$ each will be
   (a) 2 F, 6 F, 3 F and 1 F respectively
   (b) 6 F, 2 F, 3 F and 1 F respectively
   (c) 2 F, 6 F, 1 F and 3 F respectively
   (d) none of the above.

5. 100 g sample of HCl solution of relative density 1.17 contains 31.2 g of HCl. What volume of this HCl solution will be required to neutralise exactly 5 L of $\frac{N}{20}$ KOH solution?
   (a) 25 mL (b) 29.2 mL (c) 34.2 mL (d) 250 mL

6. IUPAC name of the following compound is



   (a) 6-carboxy-3-oxo-4-sulphohexanenitrile
   (b) 1-cyano-2-oxo-3 sulphohexan-6-oic acid
   (c) 7-cyano-5-oxo-4-sulphoheptan-1-oic acid
   (d) 6-cyano-5-oxo-4-sulphohexan-1-oic acid.

7. Diborane is a Lewis acid forming addition compound $B_2H_6 \cdot 2NH_3$ with NH_3, a Lewis base. This
   (i) is ionic and exists as $[BH_2(NH_3)_2]^+$ and $[BH_4]^-$ ions
   (ii) on heating, converted to borazine, $B_3N_3H_6$ (called inorganic benzene).
   Which of the following options is correct for diborane?
   (a) Only (i) (b) Only (ii)
   (c) Both are correct. (d) None is correct.

8. Copper is extracted from copper pyrites ore by heating in a blast furnace. The method is based on the principle that
   (a) copper has more affinity for oxygen than sulphur at high temperature
   (b) iron has less affinity for oxygen than sulphur at high temperature
   (c) sulphur has less affinity for oxygen at high temperature
   (d) copper has less affinity for oxygen than sulphur at high temperature.

9. The unit cell of a binary alloy composed of *A* and *B* metals, has a *ccp* structure with *A* atoms occupying the corners and *B* atoms occupying centres of each face of the cube. If during the crystallisation of this alloy, in the unit cell, two *A* atoms are missed, the overall composition per unit cell is
   (a) AB_6 (b) A_4B (c) AB_8 (d) A_6B_{24}

10. The correct order of decreasing second ionisation enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is
    (a) Mn > Cr > Ti > V (b) Ti > V > Cr > Mn
    (c) Cr > Mn > V > Ti (d) V > Mn > Cr > Ti

11. What is the maximum wavelength of light that would excite an electron from the $n = 1$ to the $n = 3$ level of atomic hydrogen?
(a) 1 nm (b) 10^{-7} nm (c) 103 nm (d) 487 nm

12. 1-Propanol and 2-propanol can be distinguished by
(a) oxidation with alkaline $KMnO_4$ followed by reaction with Fehling's solution
(b) oxidation with acidic dichromate followed by reaction with Fehling's solution
(c) oxidation by heating with copper followed by reaction with Fehling's solution
(d) oxidation with concentrated H_2SO_4 followed by reaction with Fehling's solution.

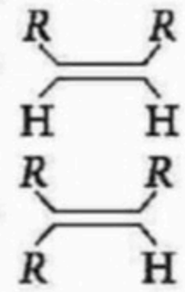
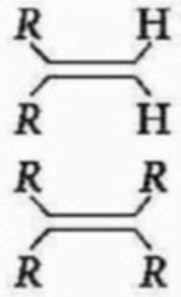
13. Which are correct statements about P_4O_6 and P_4O_{10}?
(i) Both form oxyacids H_3PO_3 and H_3PO_4 respectively.
(ii) In P_4O_6, each P is joined to four O and in P_4O_{10}, each P is joined to six O atoms.
(iii) In P_4O_6, each P is joined to three O and in P_4O_{10}, each P is joined to four O atoms.
(iv) In P_4O_6, each P is joined to three O and in P_4O_{10}, each P is joined to five O atoms.
(a) Only (i) and (iii) (b) Only (i) and (iv)
(c) Only (ii) and (iii) (d) Only (iii) and (iv)

14. The compound *A* on heating gives a colourless gas and a residue that is dissolved in water to obtain *B*. Excess of CO_2 is bubbled through aqueous solution of *B*, *C* is formed which is recovered in the solid form. Solid *C* on gentle heating gives back *A*. The compound *A* is
(a) $CaCO_3$ (b) Na_2CO_3
(c) K_2CO_3 (d) $CaSO_4 \cdot 2H_2O$

15. K_a for HCN is 5×10^{-10} at 25°C. For maintaining a constant pH of 9, the volume of 5 M KCN solution required to be added to 10 mL of 2 M HCN solution is
(a) 4 mL (b) 7.95 mL (c) 2 mL (d) 9.3 mL.

16. Three different solutions were prepared by dissolving same amount of the following complexes I, II, III in water. The freezing points of these solutions were then determined. The correct orders of freezing points will be
I. $[Co(NH_3)_3(NO_2)_3]$
II. $[Co(NH_3)_5(NO_2)]^{2+}[Co(NH_3)_2(NO_2)_4]_2$
III. $[Co(NH_3)_4(NO_2)_2][Co(NH_3)_2(NO_2)_4]$
[Given : $K_f(H_2O) = 1.86°C/m$]
(a) I > II > III (b) III > II > I
(c) II > I > III (d) I = II = III

17. Which one of the following has an optical isomer?
(a) $[Zn(en)_2]^{2+}$ (b) $[Zn(en)(NH_3)_2]^{2+}$
(c) $[Co(en)_3]^{3+}$ (d) $[Co(H_2O)_4(en)]^{3+}$

18. Which one of the following will react fastest with H_2 under catalytic hydrogenation condition?
(a)  (b) 
(c) (d)

19. When 50 cc of 0.2 N H_2SO_4 is mixed with 50 cc of 1 N KOH the heat liberated is
(a) 11.46 J (b) 57.3 kJ
(c) 573 kJ (d) 0.573 kJ

20. Which of the following amino acids contains sulphur and is an essential amino acid?
(a) Isoleucine (b) Methionine
(c) Proline (d) Glutamine

21. Which of the following statements is correct regarding the slag obtained during the extraction of a metal like copper or iron?
(a) The slag is lighter and has higher melting point than the metal.
(b) The slag is lighter and has lower melting point than the metal.
(c) The slag is heavier and has higher melting point than the metal.
(d) The slag is heavier and has lower melting point than the metal.

22. The heat of formation of $CH_3OCH_{3(g)}$ is
[Given : $B.E._{H-H} = 103$ kcal, $B.E._{C-H} = 87$ kcal $B.E._{C-O} = 70$ kcal, $B.E._{O=O} = 177$ kcal; Heat of vapourisation of 1 gram atom of carbon = 125 kcal.]
(a) −14.5 kcal (b) − 15.4 kcal
(c) + 14.5 kcal (d) + 15.4 kcal

23. What is the correct order of decreasing stability of the following cations?

$CH_3-\overset{+}{C}H-CH_3$ (I) $\quad$ $CH_3-\overset{+}{C}H-OCH_3$ (II)

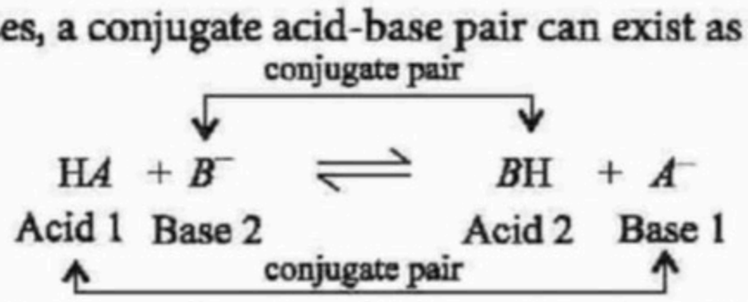
$CH_3-\overset{+}{C}H-CH_2-OCH_3$ (III)

(a) II > I > III (b) II > III > I
(c) III > I > II (d) I > II > III

24. Which has maximum number of oxo groups?
(a) H_2SO_4 (b) H_2SO_3 (c) H_3PO_3 (d) H_3PO_4

25. Morphine, heroin and codeine drugs are the examples of
(a) tranquilizers
(b) narcotic analgesics
(c) non-narcotic analgesics
(d) antihistamines.

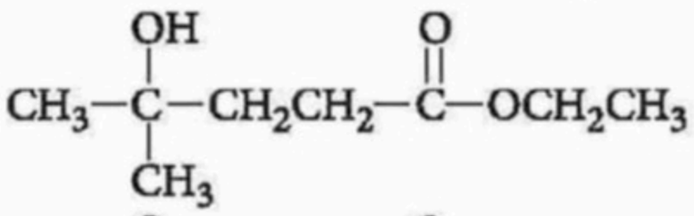
26. According to Bronsted–Lowry concept of acids and bases, a conjugate acid-base pair can exist as

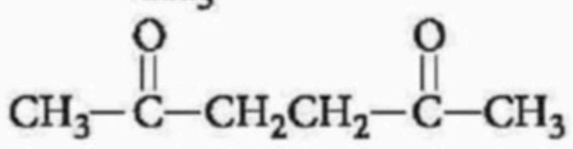


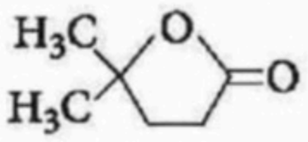
Mark the option in which conjugate pair is not correctly matched.

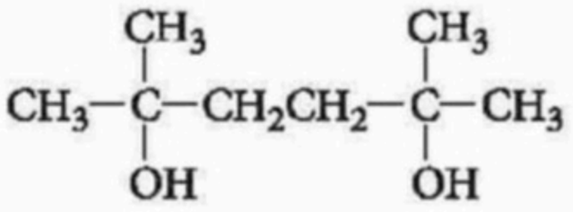
	Species	Conjugate base	Conjugate acid
(a)	HCO_3^-	CO_3^{2-}	H_2CO_3
(b)	HPO_4^{2-}	$H_2PO_4^-$	PO_4^{3-}
(c)	NH_3	NH_2^-	NH_4^+
(d)	HS^-	S^{2-}	H_2S

27. Identify (*A*) in the following reaction.

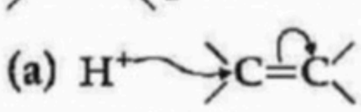
(a) 

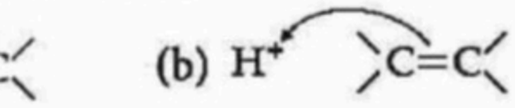
(b) 

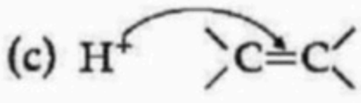
(c) 

(d) 

28. The addition of HCl to an alkene proceeds in two steps. The first step is the attack of H^+ ion to $\rangle C{=}C\langle$ portion which can be shown as

(a) 

(b) 

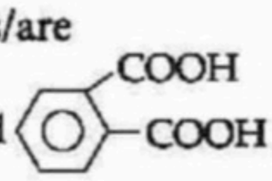
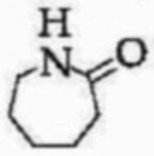
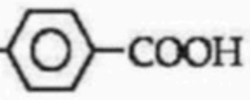
(c) 

(d) all are possible.

29. Which of the following lanthanide ions is paramagnetic ?
(a) Ce^{4+} (b) Yb^{2+}
(c) Lu^{3+} (d) Eu^{2+}

30. The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{l(l+1)}\cdot\frac{h}{2\pi}$. This momentum for an *s*-electron will be given by
(a) $+\frac{1}{2}\cdot\frac{h}{2\pi}$ (b) zero
(c) $\frac{h}{2\pi}$ (d) $\sqrt{2}\cdot\frac{h}{2\pi}$

31. In the reaction,
$C_2O_4^{2-} + MnO_4^- + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$
which species acts as a reducing agent?
(a) $C_2O_4^{2-}$ (b) MnO_4^-
(c) Mn^{2+} (d) H^+

32. The monomer of dacron is/are
(a) $HOCH_2-CH_2OH$ and 
(b) 
(c) $HOCH_2-CH_2OH$ and 
(d) $F_2C = CF_2$

33. Electrode potentials of the given half-cells,
$\underset{(I)}{Pt(H_2, p_1) \mid H^+(C_1)}$; $\underset{(II)}{Pt(Cl_2, p_2) \mid Cl^-(C_2)}$; $\underset{(III)}{Ag \mid Ag^+(C_3)}$
(a) will increase on increasing C_1, C_2 and C_3
(b) will decrease on increasing C_1, C_2 and C_3
(c) both (a) and (b)
(d) none of the above.

34. Which of the following cannot be used for the preparation of H_2?
(a) $Zn + HCl_{(dil.)} \longrightarrow$
(b) $NaH + H_2O \longrightarrow$
(c) $Zn + HNO_{3(dil.)} \longrightarrow$
(d) $HCOONa \xrightarrow{\Delta}$

35. Which of the following orders is not correct?
(a) B.E. : C — C < C = C < C ≡ C
(b) B.E. : H — F > H — Cl > H — Br > H — I
(c) B.E. : *sp* — *sp* > sp^2 — sp^2 > sp^3 — sp^3
(d) B.E. : C ≡ C > C ≡ N > N ≡ N

36. Which of the following statements regarding chemical properties of acetophenone are wrong?
I. It is reduced to methylphenylcarbinol by sodium and ethanol.
II. It is oxidised to benzoic acid with acidified $KMnO_4$.
III. It does not undergo electrophilic substitution like nitration at *meta*-position.

IV. It does not undergo iodoform reaction with iodine and alkali.

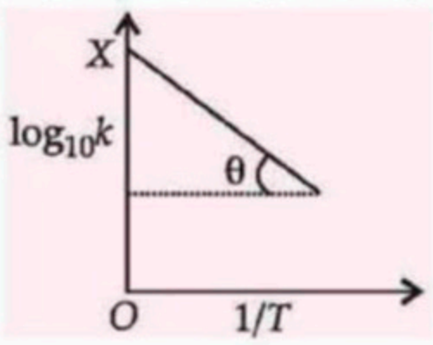
(a) Only I and II (b) Only II and IV
(c) Only III and IV (d) Only I and III.

37. Which of the following statements is false?

(a) The main reason for river water pollution is industrial and domestic sewage discharge.
(b) Surface water contains a lot of organic matter, mineral nutrients and radioactive materials.
(c) Oil spill in sea water causes heavy damage to fishery.
(d) Oil slick in sea water increases D.O. value.

38. Graph between log k and $1/T$ [where k is rate constant (in s^{-1}) and T is the temperature (in K)] is a straight line with $OX = 5$, $\theta = \tan^{-1}(1/2.303)$. Hence, $-E_a$ will be

(a) 2.303×2 cal
(b) $\frac{2}{2.303}$ cal
(c) 2 cal
(d) none of these.



39. The reaction of benzenesulphonyl chloride with ethylamine yields

(a) *N*-ethylbenzenesulphonamide, insoluble in alkali
(b) *N*, *N*-diethylbenzenesulphonamide, soluble in alkali
(c) *N*, *N*-diethylbenzenesulphonamide, insoluble in alkali
(d) *N*-ethylbenzenesulphonamide, soluble in alkali.

40. Ionic radii are

(a) directly proportional to square of effective nuclear charge
(b) inversely proportional to effective nuclear charge
(c) inversely proportional to square of effective nuclear charge
(d) directly proportional to effective nuclear charge.

SOLUTIONS

1. (a): Number of atoms in 1 gram of an element

$$= \frac{6.023\times10^{23}}{\text{At. mass}} \times 1$$

$\therefore$ Number of atoms in 2 grams of oxygen

$$= \frac{6.023\times10^{23}}{16} \times 2 = \frac{6.023\times10^{23}}{8}$$

Number of atoms in 4 grams of sulphur

$$= \frac{6.023\times10^{23}}{32} \times 4 = \frac{6.023\times10^{23}}{8}$$

Number of atoms in 7 grams of nitrogen

$$= \frac{6.023\times10^{23}}{14} \times 7 = \frac{6.023\times10^{23}}{2}$$

Number of atoms in 0.5 grams of hydrogen

$$= \frac{6.023\times10^{23}}{1} \times 0.5 = \frac{6.023\times10^{23}}{2}$$

Number of atoms in 2.3 grams of sodium

$$= \frac{6.023\times10^{23}}{23} \times 2.3 = \frac{6.023\times10^{23}}{10}$$

2. (a): $CH_2(Cl)-CH_2-CH_2(Cl) \xrightarrow[\text{or 2Na}]{\text{Mg or Zn}} \triangle + MgCl_2$ or $ZnCl_2$ or 2NaCl

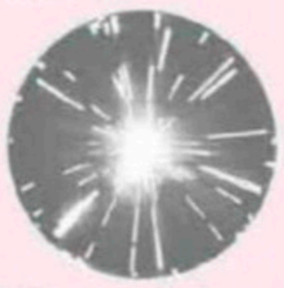
Some Fascinating Facts Around the World!

Lightning strikes produce Ozone, hence everything seems fresh after thunderstorms.

Ozone, the triple oxygen molecule that acts as a saviour against ultraviolet rays, is created in nature by lightning. When it strikes, the lightning breakdown oxygen molecules in the atmosphere into radicals which reform into ozone.

The smell of ozone is very sharp, often described as similar to that of chlorine. This is why you get that "clean" smell sensation after a thunderstorm.

Every hydrogen atom in your body is old as they were formed likely 13.5 billion years at the birth of the universe.



At ground zero, before the big bang, the very first chemical element was hydrogen. All the other followed by fusing hydrogen into helium, which then fused into carbon and so on. Approximately 73% of the mass of the visible universe is in the form of hydrogen. Helium makes up about 25% of the mass, and everything else represents only 2%. By mass, hydrogen and helium combined make up less than 1% of the Earth.

Can you write your address in the form of chemical elements? Sounds interesting!

Famed chemist Glenn Seaborg was the only person who could write his address in chemical elements. He wrote Sg, Lr, Bk, Cf, Am. That's Seaborgium (Sg), named after Seaborg himself; Lawrencium (Lr), named after the Lawrence Berkeley National Laboratory; Berkelium (Bk), named after the city of Berkeley, the home of UC Berkeley; Californium (Cf), named after the state of California; Americium (Am), named after America.

This time thanks giving goes to Saliva

Food is a neccessity for survival, however, food that tastes good is one of the greatest pleasures of life. You can thank your saliva for this, as without that moisture, you wouldn't be able to taste anything. Saliva works to break down the foods, which in turn dissolves the chemicals onto the tongue's taste receptors.

α and γ-dihalogen derivatives of an alkane on treatment with Mg or Zn or Na give cycloalkanes.

3. (b): Isoelectric point is that pH value at which no migration of dispersed phase takes place under the influence of electric field.

4. (a): $CuSO_4 + 2e^- \longrightarrow Cu + SO_4^{2-}$

$Bi_2(SO_4)_3 + 6e^- \longrightarrow 2Bi + 3SO_4^{2-}$

$AlCl_3 + 3e^- \longrightarrow Al + 3Cl^-$

$AgNO_3 + e^- \longrightarrow Ag + NO_3^-$

Since, in 1 M $CuSO_4$ solution, 1 M $Bi_2(SO_4)_3$ solution, 1 M $AlCl_3$ solution and 1 M $AgNO_3$ solution, 2 moles of electrons, 6 moles of electrons, 3 moles of electrons and 1 mole of electrons are needed to deposit Cu, Bi, Al and Ag at the cathode respectively.

But one mole of electrons = 1 F electricity

That's why number of Faradays required to deposit 1 M of each $CuSO_4$, $Bi_2(SO_4)_3$, $AlCl_3$ and $AgNO_3$ solution are 2F, 6F, 3F and F respectively.

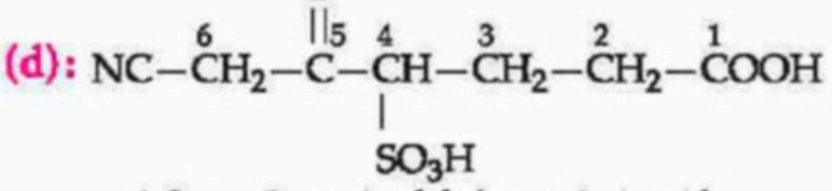
5. (a): Normality of HCl solution

$$= \frac{31.2}{36.5} \times \frac{1000 \times 1.17}{100} = 10$$

(HCl) $N_1V_1 = N_2V_2$ (KOH)

$$V_1 = \frac{1}{20} \times 5 \times \frac{1}{10} = 0.025 \text{ L} \Rightarrow 25 \text{ mL}$$

6. (d):



6-Cyano-5-oxo-4-sulphohexan-1-oic acid

7. (c): The addition product, $B_2H_6 \cdot 2NH_3$ is considered as an ionic product and on heating to 200 °C, it forms a volatile compound called borazine.

8. (a): Extraction of copper from copper pyrite ore by heating it in a blast furnace is based on the fact that copper has more affinity for oxygen than sulphur at high temperature.

9. (d): 8 *A* atoms are present at the corners but 2 *A* atoms are missed,

hence, contribution of $A = 6 \times \frac{1}{8} = \frac{6}{8}$

B atoms are present at the face centres,

hence, contribution of $B = 6 \times \frac{1}{2} = 3$

So, $A_{6/8}B_3$ or A_6B_{24}

10. (c): The electronic configurations of M^+ ions are

Cr^+: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$ – Stable configuration

Mn^+ : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

V^+ : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^1$

Ti^+ : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^1$

In general, ionisation energy (both 1st and 2nd) increases from left to right across the period due to increase in effective nuclear charge. On this basis, the second ionisation energy values should exhibit the trend, Mn > Cr > V > Ti. But the actual observed order is Cr > Mn > V > Ti. Practically, only chromium is exceptional and rest others show the normal trend. This exceptional behaviour of chromium is due to the stable configuration ($3d^5$) that it achieves after the loss of first electron.

11. (c): $E_n = \frac{-2\pi^2 Z^2 e^4 m}{h^2 n^2} = \frac{-1312}{n^2}$ kJ mol^{-1}

$\Delta E = E_{final} - E_{initial}$

$$\Delta E = -1312 \left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right] \text{kJ mol}^{-1}$$

$$\Delta E = -1312 \left[\frac{1}{9} - \frac{1}{1}\right] \text{kJ mol}^{-1}$$

$$= 1312 \times \frac{8}{9} \times \frac{1000}{6.023 \times 10^{23}} \text{ J atom}^{-1} \text{ ; } \Delta E = \frac{hc}{\lambda} \text{ or } \lambda = \frac{hc}{\Delta E}$$

$$\lambda = 6.626 \times 10^{-34} \times 3.0 \times 10^8 \times \frac{6.023 \times 10^{23} \times 9}{1312 \times 8 \times 1000}$$

$= 0.103 \times 10^{-6}$ m = 103 nm

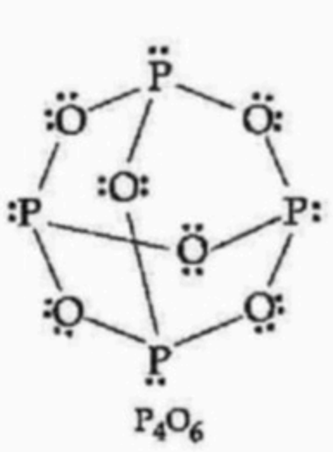
12. (c): 1-Propanol and 2-propanol in presence of Cu/Δ undergo dehydrogenation to give acetaldehyde and acetone respectively which can be distinguished by Fehling's solution since acetaldehyde reduces while acetone does not reduce Fehling's solution.

In contrast with alkaline $KMnO_4$ or acidic $K_2Cr_2O_7$, 1-propanol will first give propionaldehyde which will be readily oxidised to propionic acid while 2-propanol will first give acetone and then on further oxidation will give acetic acid. Both these acids cannot be distinguished by Fehling's solution. Option (d) is incorrect since conc. H_2SO_4 does not bring about oxidation of alcohols.

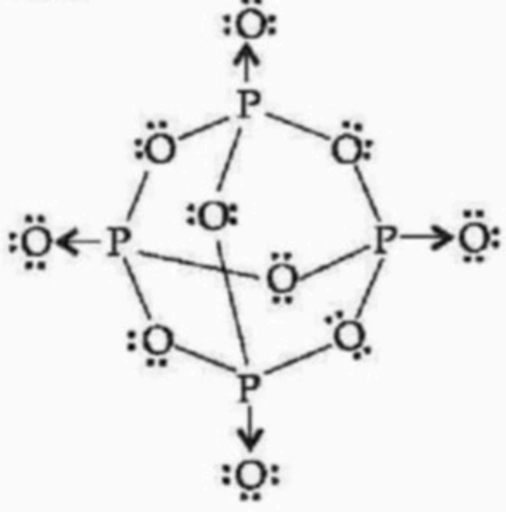
13. (a): $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$

$P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$

In P_4O_6, each P is joined to three O and in P_4O_{10} each P is joined to four O atoms.



P_4O_6



P_4O_{10}

14. (a): The reactions can be summarised as follows :

$$A \xrightarrow{\Delta} \text{colourless gas + residue}$$

$$\text{Residue} + H_2O \longrightarrow B \xrightarrow[\text{excess}]{CO_2} C \xrightarrow{\Delta} A$$

This is possible only when A is $CaCO_3$.

The reactions are as follows :

$$\underset{(A)}{CaCO_3} \xrightarrow{\Delta} \underset{\text{(colourless gas)}}{CO_2} + \underset{\text{(residue)}}{CaO}$$

$$CaO + H_2O \longrightarrow \underset{(B)}{Ca(OH)_2} \xrightarrow[\text{(excess)}]{CO_2}$$

$$\underset{(C)}{Ca(HCO_3)_2} \xrightarrow{\Delta} \underset{(A)}{CaCO_3}$$

15. (c): $pH = pK_a + \log \dfrac{[\text{Salt}]}{[\text{Acid}]}$

$$9 = -\log (5 \times 10^{-10}) + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

$$\log \frac{[\text{Salt}]}{[\text{Acid}]} = 9 + \log (5 \times 10^{-10})$$

$$= 9 + (0.699 - 10) = -0.3010$$

$$\frac{[\text{Salt}]}{[\text{Acid}]} = \text{Antilog } (-0.3010) = 0.5$$

Suppose volume of 5 M KCN to be added = V cc

Then total volume of HCN + KCN = $10 + V$ cc

In the final solution, V cc of 5 M KCN = $(10 + V)$ cc of x M KCN

$$\text{Molarity of KCN, } x = \frac{5V}{10+V}$$

$$\text{Molarity of HCN, } y = \frac{10 \times 2}{10+V}$$

$$\text{As, } \frac{[\text{Salt}]}{[\text{Acid}]} = 0.5 \quad \therefore \quad \frac{5V/(10+V)}{20/(10+V)} = 0.5$$

$$\Rightarrow V/4 = 0.5 \text{ or } V = 2 \text{ cc.}$$

16. (d): In each case, same number of mole particles are formed so ΔT_f is same.

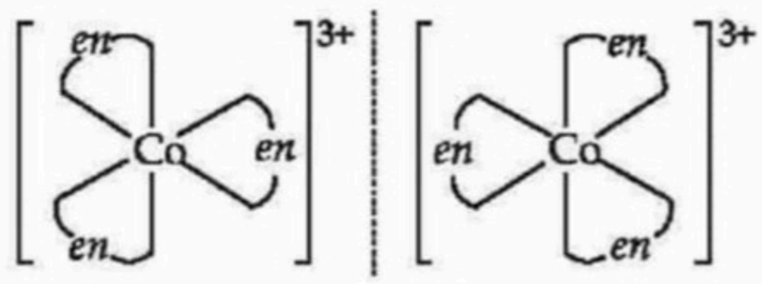
I. $\dfrac{W \times 1}{248} =$ 'X' mol (Only 1 particle formed)

II. $\dfrac{W}{744} \times 3 = \dfrac{W}{248} =$ 'X' mol (3 ions formed)

III. $\dfrac{W \times 2}{496} = \dfrac{W}{248} =$ 'X' mol (2 ions formed)

17. (c): Optical isomers rarely occur in square planar complexes due to the presence of axis of symmetry.

Optical isomerism is common in octahedral complexes of the general formula, $[Ma_2b_2c_2]^{n\pm}$, $[Mabcdef]$, $[M(AA)_3]^{n\pm}$, $[M(AA)_2a_2]^{n\pm}$, $[M(AA)_2ab]^{n\pm}$ and $[M(AB)_3]^{n\pm}$. Thus, among the given options, only $[Co(en)_3]^{3+}$ shows optical isomerism.



18. (a): From amongst given olefins (a) and (b) are less stable (Saytzeff's rule). Moreover *syn*-isomer is more reactive than *anti*-because of steric hindrance.

19. (d): No. of g equivalents of $H_2SO_4 = 0.2 \times 50 \times 10^{-3}$

$= 0.01$ g eq.

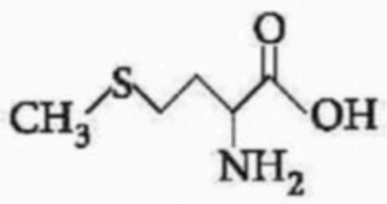
No. of g equivalents of KOH $= 1 \times 50 \times 10^{-3} = 0.05$ g eq.

0.01 g eq. of $H_2SO_4 \equiv 0.01$ g eq. of KOH

Heat of neutralisation for 1 equivalent = 57.3 kJ g^{-1} eq^{-1}

For 0.01 g equivalent heat released = $57.3 \times 0.01 = 0.573$ kJ

20. (b): Methionine is an essential amino acid which contains sulphur.



Methionine

21. (b): Slag is lighter, has lower m.pt. than metal, hence it floats and can be skimmed off.

22. (a): The formation of CH_3OCH_3 may be represented as :

$$2C_{(s)} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_3C - O - CH_3;\ \Delta H = ?$$

It involves vapourisation of 2 gram atoms of solid carbon and breaking 3 moles of H – H bonds and $\frac{1}{2}$ mole of O=O bonds resulting in the formation of 6 C – H bonds and 2C – O bonds. Thus, the heat of formation of $CH_3 - O - CH_3$ is given by

$$\Delta H = (2 \times 125 + 3 \times 103 + \frac{1}{2} \times 177) - (6 \times 87 + 2 \times 70)$$

$$= -14.5 \text{ kcal}$$

Monthly Test Drive CLASS XI ANSWER KEY

1. (a)	2. (c)	3. (c)	4. (b)	5. (c)
6. (d)	7. (c)	8. (a)	9. (d)	10. (c)
11. (a)	12. (a)	13. (d)	14. (c)	15. (b)
16. (a)	17. (b)	18. (b)	19. (c)	20. (b,c)
21. (a,b)	22. (b,c,d)	23. (b,c,d)	24. (7)	25. (5)
26. (7)	27. (c)	28. (b)	29. (a)	30. (a)

23. (a): $CH_3 \rightarrow \overset{+}{C}H \leftarrow CH_3$ (I) $\quad CH_3-\overset{+}{C}H-\ddot{O}-CH_3$ (II)

Stabilized by weak +*I* effect of the two methyl groups

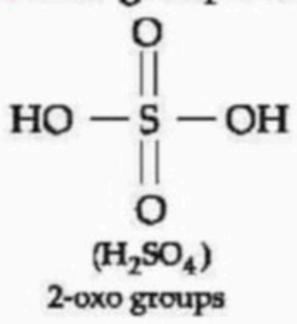
Stabilized by strong +*R* effect of the $-OCH_3$ groups

$CH_3-\overset{+}{C}H \rightarrow CH_2 \rightarrow OCH_3$ (III)

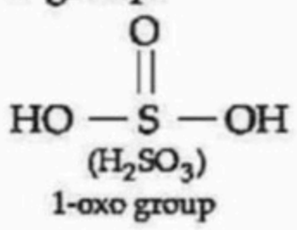
Destabilized by –*I* effect of the $-OCH_3$ group

Thus, the stability of carbocations decreases in the order II > I > III.

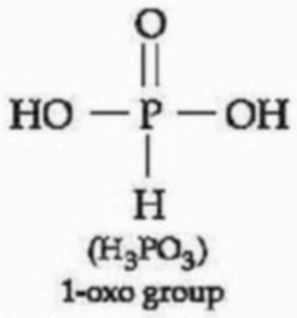
24. (a): Oxo group means *M*=O group.



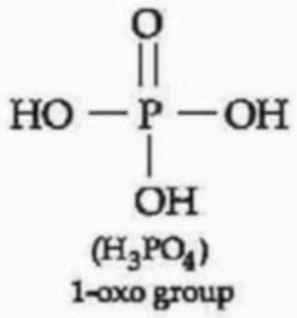
(H_2SO_4) 2-oxo groups



(H_2SO_3) 1-oxo group



(H_3PO_3) 1-oxo group

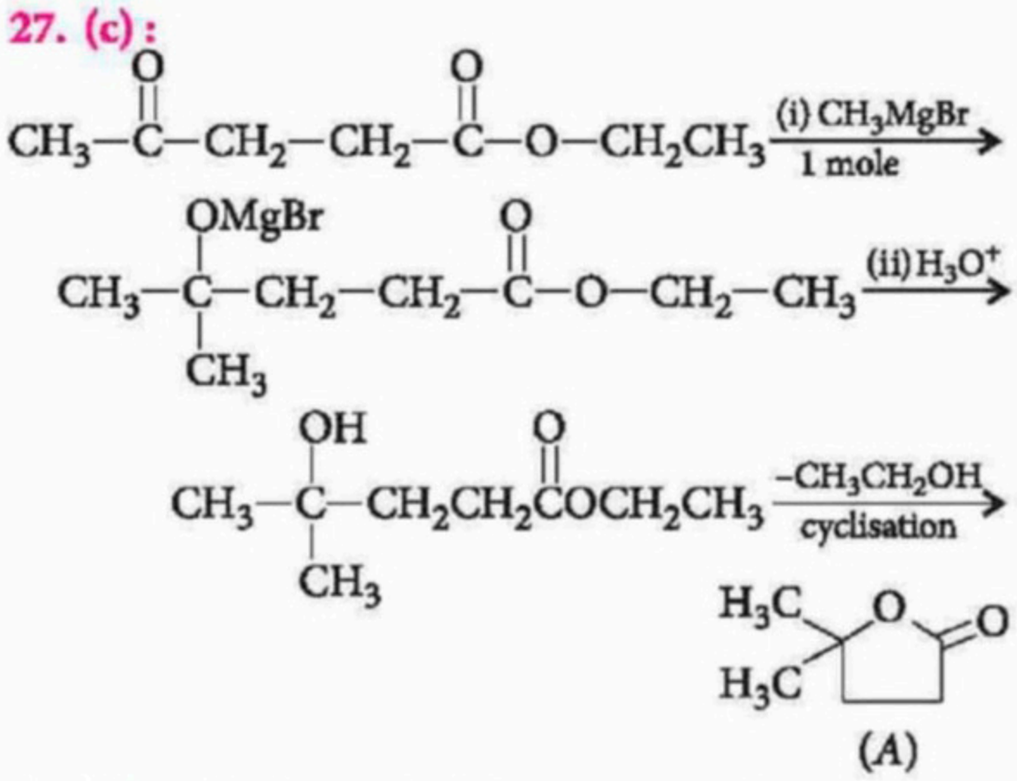


(H_3PO_4) 1-oxo group

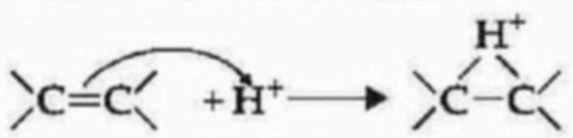
25. (b): Morphine and many of its homologues compounds relieve pain and produce sleep. They come under narcotic analgesics.

26. (b)

27. (c):



28. (b): Addition of HCl to an alkene follows Markownikoff's rule and first step is the capture of proton by electron clouds of π-bond.



29. (d): $Ce \rightarrow [Xe]\ 4f^1\ 5d^1\ 6s^2$; $Ce^{4+} \rightarrow [Xe]$

$Yb \rightarrow [Xe]\ 4f^{14}\ 6s^2$; $Yb^{2+} \rightarrow [Xe]\ 4f^{14}$

$Lu \rightarrow [Xe]\ 4f^{14}\ 5d^1\ 6s^2$; $Lu^{3+} \rightarrow [Xe]\ 4f^{14}$

$Eu \rightarrow [Xe]\ 4f^7\ 6s^2$; $Eu^{2+} \rightarrow [Xe]\ 4f^7$

30. (b): The value of *l* (azimuthal quantum number) for *s*-electron is equal to zero.

Orbital angular momentum = $\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$

Substituting the value of *l* for *s*-electron

$= \sqrt{0(0+1)} \cdot \frac{h}{2\pi} = 0$

31. (a): $\overset{+3}{C_2}\overset{2-}{O_4} + \overset{+7}{Mn}\overset{-1}{O_4} + H^+ \rightarrow \overset{+2}{Mn} + \overset{+4}{CO_2} + H_2O$

Oxidation number increases (oxidation)

Reducing agent is that species whose oxidation number increases.

32. (c)

33. (d): $1/2\ H_2 \rightarrow H^+ + e^-$

$K = [H^+] = C_1$

$E = E^\circ - 0.0591 \log C_1$

E decreases if C_1 increases.

$Cl^- \longrightarrow \frac{1}{2} Cl_2 + e^-$; $K = \frac{1}{[Cl^-]} = \frac{1}{C_2}$

$E = E^\circ + 0.0591 \log C_2$

E increases if C_2 increases.

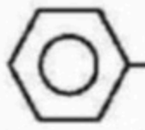
$Ag \rightarrow Ag^+ + e^-$

$E = E^\circ - 0.0591 \log C_3$; *E* decreases if C_3 increases.

34. (c): $4Zn + 10HNO_{3(dil.)} \longrightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$

35. (d): $B.E. \propto \frac{1}{\text{At. size}}$

Hence, the order of bond energy is C ≡ C < C ≡ N < N ≡ N

36. (c): Acetophenone,  undergoes electrophilic substitution reaction and also gives positive iodoform test with iodine and alkali.

37. (d)

38. (c): $\log k = \log A - \frac{E_a}{2.303RT}$

$\text{Slope} = \frac{-E_a}{2.303\,R} = \tan\theta = \frac{1}{2.303}$ (given)

$-E_a = 2.303R \times \text{Slope} = 2.303\,R \times \frac{1}{2.303}$

By substituting the value of $R = 2$ cal K^{-1} mol^{-1} we get, $-E_a = 2$ cal

39. (d)

40. (b): Ionic radii is inversely proportional to effective nuclear charge.

JEE 2020 ADVANCED

PRACTICE PAPER

Exam on 17th May

PAPER - I

SECTION 1 (Maximum Marks : 12)

- *This section contains FOUR (04) questions.*
- *Each question has FOUR options. ONLY ONE of these four options is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks :	*+3*	*If ONLY the correct option is chosen.*
Zero Marks :	*0*	*If none of the options is chosen (i.e., the question is unanswered).*
Negative Marks :	*–1*	*In all other cases.*

1. Traces of fluoride ions (F^-) in drinking water (about 1 ppm) greatly reduce the incidence of dental cavities (tooth decay). What is the reason for reduction in cavities?

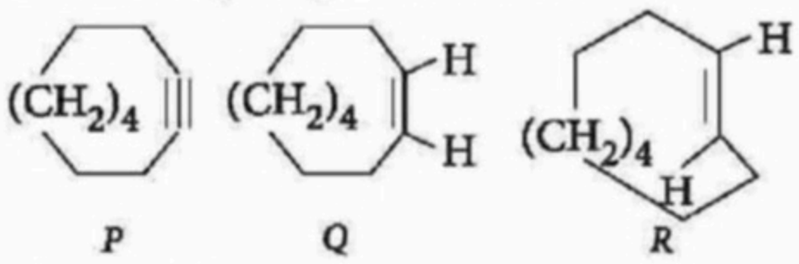
(a) The enamel $[3Ca_3(PO_4)_2 \cdot CaF_2]$ on the surface of teeth is converted to much harder $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$.

(b) The enamel $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$ on the surface of teeth is converted to much harder $[3Ca_3(PO_4)_2 \cdot CaF_2]$.

(c) The enamel $[Ca(OH)_2]$ on the surface of teeth is converted to CaF_2.

(d) The enamel $[Ca_3(PO_4)_2 \cdot Ca(OH)_2]$ on the surface of teeth is converted to much harder $[3Ca_3(PO_4)_2 \cdot CaF_6]$.

2. Reactant *P* gives products *Q* and *R*,



P *Q* *R*

The possible reagents are

(I) $2Na/liq.\ NH_3$

(II) $H_2/Pd/CaCO_3$ (quinoline)

(III) $2H_2/Pd/C$

The correct statement with respect to the conversions is

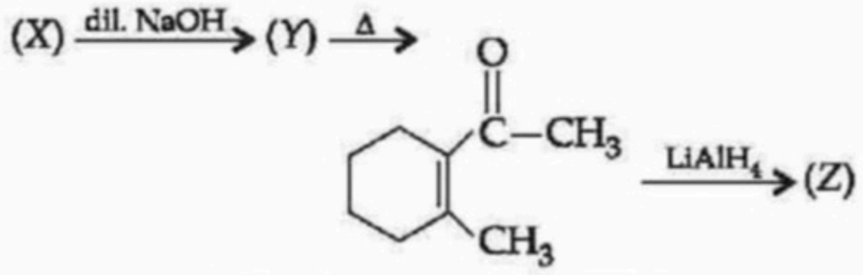
(a) *Q* is obtained on treatment with reagent (I)

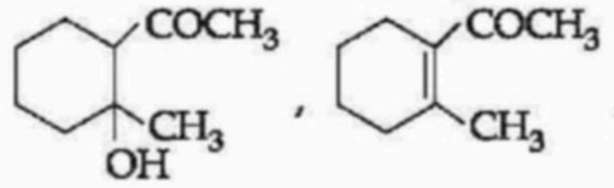
(b) *R* and *Q* are obtained on treatment with reagent (III)

(c) *R* is obtained on treatment with reagent (II)

(d) *R* is obtained on treatment with reagent (I).

3. *X*, *Y* and *Z* in the following reactions are respectively,



(a) 

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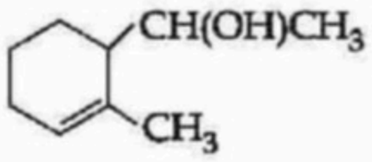
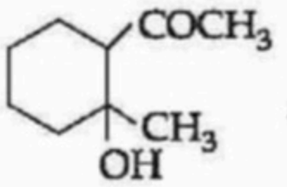


(b) $CH_3CO(CH_2)_5COCH_3$, 

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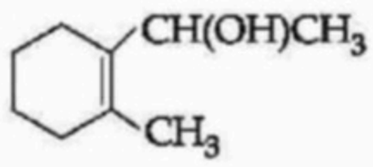
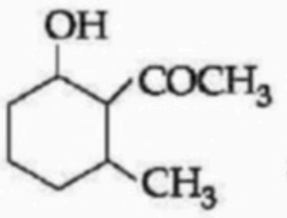


(c) $CH_3CO(CH_2)_4COCH_3$, 

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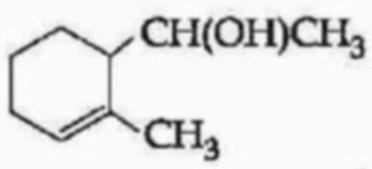
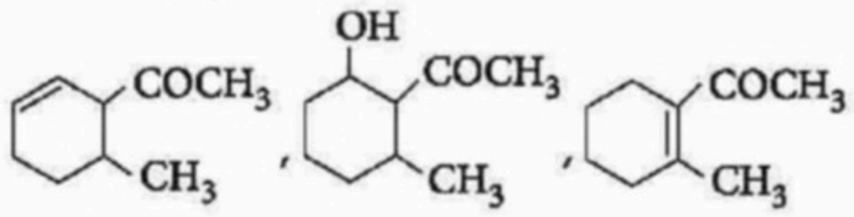


(d) 

, ,

4. KI (excess) is added to the following solutions separately

(I) $CuSO_4$ (II) $HgCl_2$ (III) $Pb(NO_3)_2$

The correct observation is

(a) a white precipitate of Cu_2I_2 in (I), an orange precipitate of HgI_2 in (II) which further dissolves and a yellow precipitate of PbI_2 in (III) are formed

(b) white precipitates of Cu_2I_2, HgI_2 and PbI_2 are formed respectively

(c) yellow precipitate in each case is formed

(d) a white precipitate of Cu_2I_2 in (I), a blue precipitate of K_2HgI_4 in (II) and a yellow precipitate of PbI_2 in (III) are formed.

SECTION 2 (Maximum Marks : 32)

- ***This section contains EIGHT (08) questions.***
- ***Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).***
- ***For each question, choose the option(s) corresponding to (all) the correct answer(s).***
- ***Answer to each question will be evaluated according to the following marking scheme :***

Full Marks : +4 ***If only (all) the correct option(s) is (are) chosen.***

Partial Marks : +3 ***If all the four options are correct but ONLY three options are chosen.***

Partial Marks : +2 ***If three or more options are correct but ONLY two options are chosen and both of which are correct.***

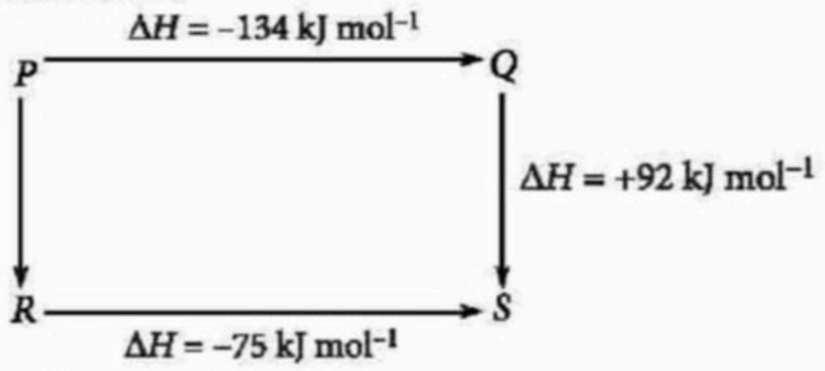
Partial Marks : +1 ***If two or more options are correct but ONLY one option is chosen and it is a correct option.***

Zero Marks : 0 ***If none of the options is chosen (i.e., the question is unanswered).***

Negative Marks : −1 ***In all other cases.***

- ***For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks;***
choosing ONLY (a) and (b) will get +2 marks;
choosing ONLY (a) and (d) will get +2 marks;
choosing ONLY (b) and (d) will get +2 marks;
choosing ONLY (a) will get +1 mark;
choosing ONLY (b) will get +1 mark;
choosing ONLY (d) will get +1 mark;
choosing no option (i.e., the question is unanswered) will get 0 marks ; and
choosing any other combination of options will get −1 mark.

5. The diagram illustrates the energy changes of a set of reactions :



Which of the following statements is/are correct ?

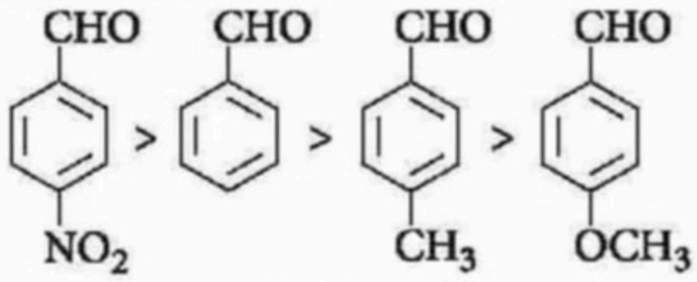
(a) The enthalpy change for the reaction $P \rightarrow R$ is – 33 kJ mol^{-1}.

(b) The enthalpy change for the transformation $R \rightarrow Q$ will be endothermic.

(c) The enthalpy change for the transformation $R \rightarrow Q$ will be exothermic.

(d) The enthalpy change for the transformation $S \rightarrow P$ will be +42 kJ mol^{-1}.

6. Which of the following is/are arranged in correct order as indicated?

(a) 

[Nucleophilic addition reaction]

(b) $CH_3COCl > (CH_3CO)_2O > CH_3COOCH_3 > CH_3CO\ddot{N}H_2$ [Acyl S_N2 reaction]

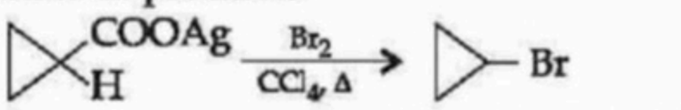
(c) $CH_3CH_2COOH > CH_3COOH > HCOOH$ [Rate of esterification reaction]

(d) $CH_3COOCH_3 > CH_3COOC_2H_5 > CH_3COOC_3H_7$ [Rate of hydrolysis]

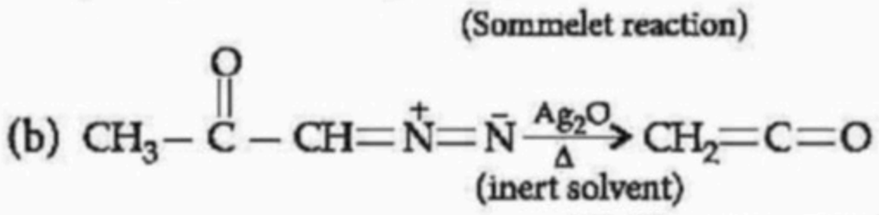
7. Of the following, the metal(s) that cannot be obtained by electrolysis of the aqueous solution of their salts is/are

(a) Ag (b) Mg (c) Cu (d) Al

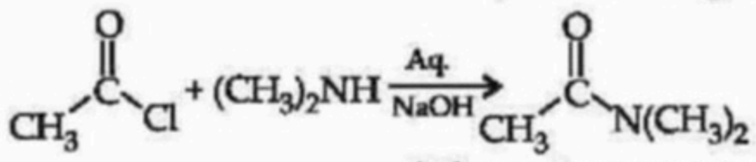
8. Few reactions along with their names are given below. Find the incorrect one(s) either with respect to name or product.

(a) 

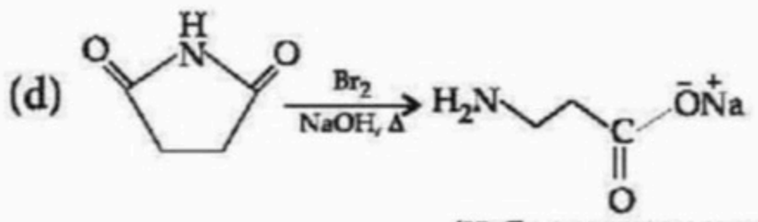
(Sommelet reaction)

(b) 

(Wolff rearrangement)

(c) 

(Schotten-Baumann reaction)

(d) 

(Hoffmann rearrangement)

9. Select the correct statement(s) if 9.65 amperes current is passed for 1 hour through the cell,

$$Ag\,|\,Ag^+(1\ M)\,||\,Cu^{2+}(1\ M)\,|\,Cu$$

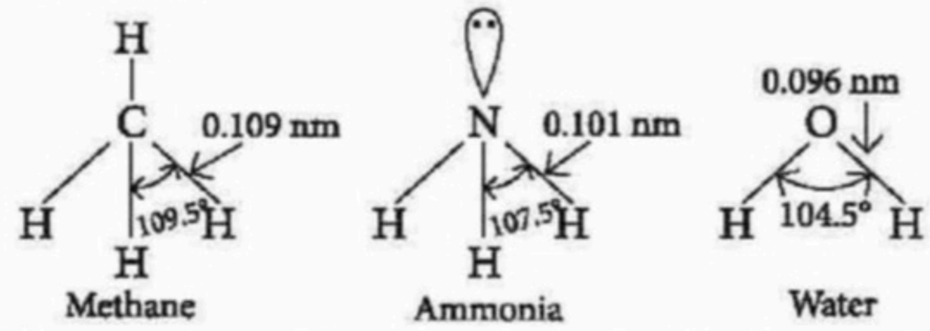
(a) Ag will oxidise to Ag^+ and new $[Ag^+] = 1.36$ M

(b) Ag^+ will reduce to Ag and new $[Ag^+] = 0.64$ M

(c) Cu^{2+} will reduce to Cu and new $[Cu^{2+}] = 0.82$ M

(d) Cu will oxidise to Cu^{2+} and new $[Cu^{2+}] = 0.82$ M

10. The bond lengths and bond angles in the molecules of methane, ammonia and water may be represented as follows :

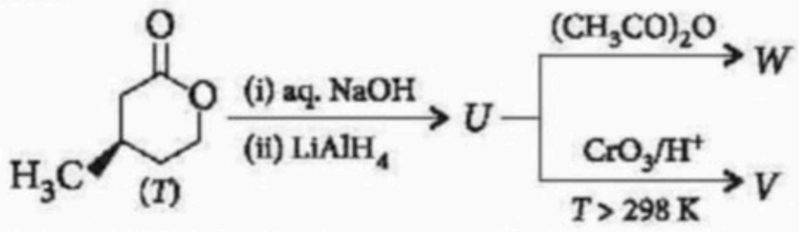


Choose the correct statement(s) regarding the trend.

(a) Bond angle increases due to increase in no. of non-bonding electron pairs.

(b) Increasing repulsion between hydrogen atoms cause bond length to decrease.
(c) Decreasing bond angle is caused due to decreasing bond pair-bond pair repulsion.
(d) Increasing *s*-characteristics in bonding hybridised orbital cause decrease in bond length.

11. With reference to the scheme given, which of the given statements about *T*, *U*, *V* and *W* is/are correct?



(a) *T* is soluble in hot aqueous NaOH.
(b) *U* is optically active.
(c) Molecular formula of *W* is $C_{10}H_{18}O_4$.
(d) *V* gives effervescence on treatment with aqueous $NaHCO_3$.

12. If there are three possible values $\left(-\frac{1}{2}, 0, +\frac{1}{2}\right)$ for the spin magnetic quantum number (m_s). Which of the following statements is/are correct regarding a hypothetical periodic table based on this condition?
(a) First period would have only 2 vertical columns.
(b) Second period would have 12 elements.
(c) Third period would have 12 elements.
(d) Second period would have 14 elements.

SECTION 3 (Maximum Marks : 18)

- *This section contains SIX (06) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks : +3 *If ONLY the correct numerical value is entered.*
Zero Marks : 0 *In all other cases.*

13. If you are initially provided with 224 g of pure chromite ore and 169.6 g of sodium carbonate then the minimum volume of air required at NTP to consume atleast one of the reactant completely, if air contains 20% by volume of oxygen gas, is _____.

14. A Duma's bulb of air weighs 22.567 g at 20°C and 755 mm Hg pressure. Filled with vapours of a substance at 120°C and at the same pressure then it weighs 22.8617 g. The capacity of the bulb is 200 mL. The molecular mass of the substance is _____.
(Density of air = 0.00129 g/mL)

15. The coordination number exhibited by K^+ when it forms a complex with salicylaldehyde is _____.

16. A tetrapeptide has —COOH group on alanine. This produces glycine (gly), phenylalanine (phe), valine (val) and alanine (ala) on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with $-NH_2$ group attached to a chiral centre is _____.

17. A 500 mL sample of an equilibrium mixture of gaseous N_2O_4 and NO_2 at 25 °C and 753 mm Hg was allowed to react with enough water to make 250 mL of solution at 25 °C. Assume that all the dissolved N_2O_4 is converted to NO_2 which disproportionates in water yielding a solution of nitrous acid and nitric acid. Assume that further disproportionation reaction goes to completion and that none of the nitrous acid disproportionates. The equilibrium constant (K_p) for, $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ is 0.113 at 25°C. The pH of the solution is _____.

18. An organic compound ($C_xH_{2y}O_y$) was burnt with twice the amount of oxygen needed for complete combustion to CO_2 and H_2O. The hot gases when cooled to 0°C and 1 atm pressure, measured 2.24 litres. The water collected during cooling weighed 0.9 g. The vapour pressure of pure water at 20°C is 17.5 mm Hg and is lowered by 0.104 mm when 50 g of the organic compound are dissolved in 1000 g of water. The molecular weight of the organic compound is _____.

PAPER - II

SECTION 1 (Maximum Marks : 32)

- *This section contains EIGHT (08) questions.*
- *Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme :*
- *Full Marks :* +4 *If only (all) the correct option(s) is (are) chosen.*
- *Partial Marks :* +3 *If all the four options are correct but ONLY three options are chosen.*
- *Partial Marks :* +2 *If three or more options are correct but ONLY two options are chosen and both of which are correct.*
- *Partial Marks :* +1 *If two or more options are correct but ONLY one option is chosen and it is a correct option.*
- *Zero Marks :* 0 *If none of the options is chosen (i.e. the question is unanswered).*
- *Negative Marks :* –1 *In all other cases.*
- *For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then*
- *choosing ONLY (a), (b) and (d) will get +4 marks;*
- *choosing ONLY (a) and (b) will get +2 marks;*
- *choosing ONLY (a) and (d) will get +2 marks;*
- *choosing ONLY (b) and (d) will get +2 marks;*
- *choosing ONLY (a) will get +1 mark;*
- *choosing ONLY (b) will get +1 mark;*
- *choosing ONLY (d) will get +1 mark;*
- *choosing no option (i.e. the question is unanswered) will get 0 marks ; and*
- *choosing any other combination of options will get –1 mark.*

1. Which of the following statements is/are incorrect?

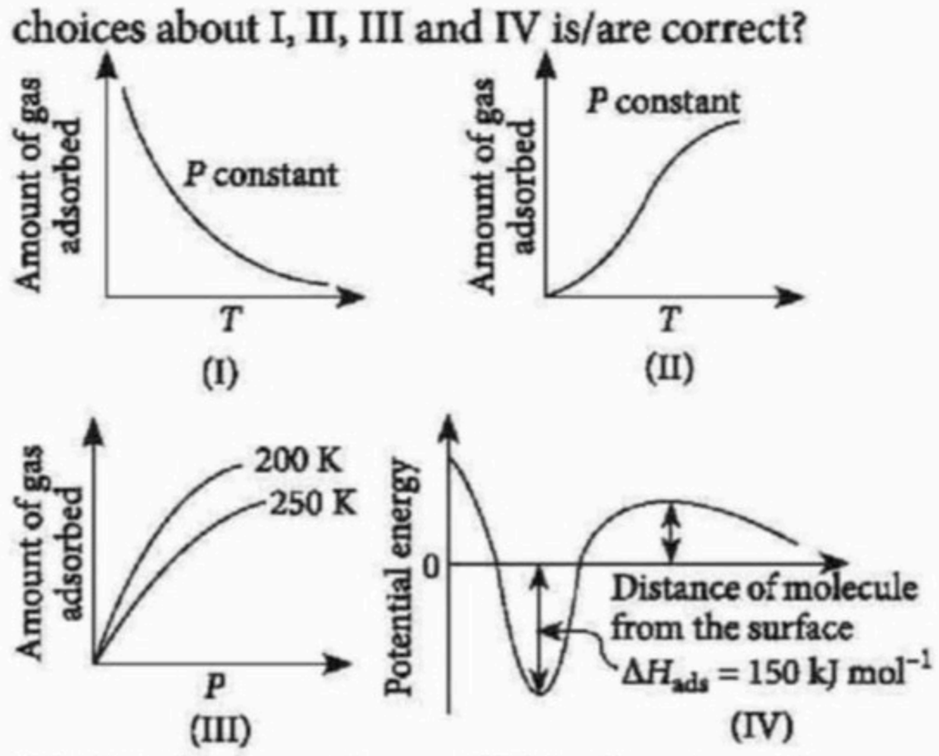
(a) Among O_2^+, O_2 and O_2^- the stability decreases in the order $O_2^+ > O_2 > O_2^-$.

(b) He_2 molecule does not exist as the effect of bonding and anti-bonding molecular orbitals cancel each other.

(c) C_2, O_2^{2-} and Li_2 are diamagnetic.

(d) In F_2 molecule, the energy of $\sigma 2p_z$ is more than $\pi 2p_x$ and $\pi 2p_y$.

2. The given graphs/data I, II, III and IV represent general trends observed for different physisorption and chemisorption processes under mild conditions of temperature and pressure. Which of the following choices about I, II, III and IV is/are correct?



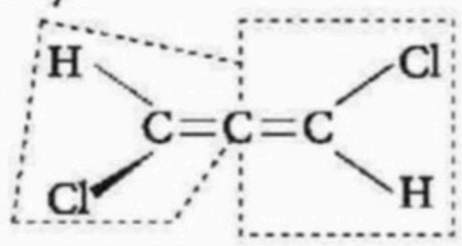
(a) I is physisorption and II is chemisorption.

(b) I is physisorption and III is chemisorption.

(c) IV is chemisorption and II is chemisorption.

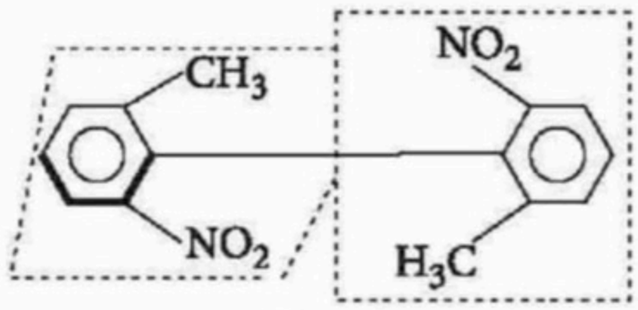
(d) IV is chemisorption and III is chemisorption.

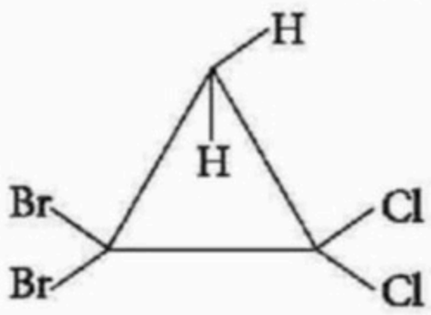
3. Which of the following do/does not show optical activity?

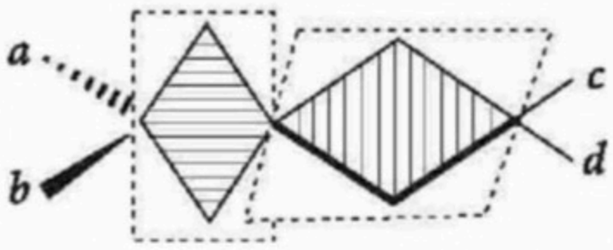
(a) 

EXAM CORNER 2020

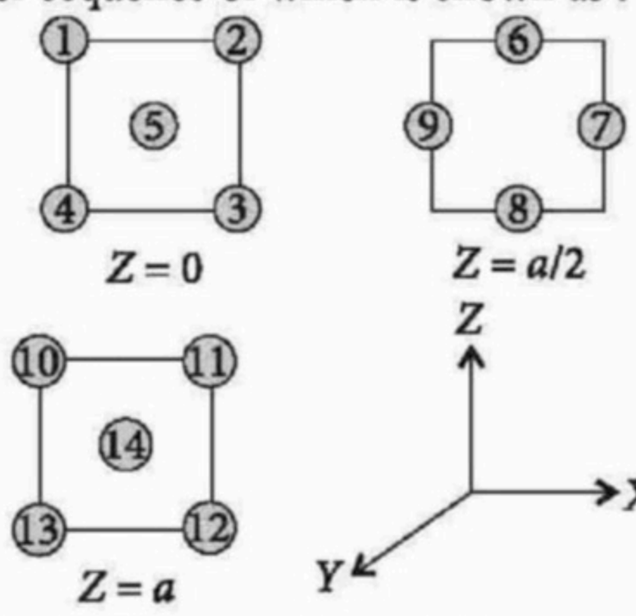
Exam	Date
VITEEE	13th to 19th April
SRMJEEE	12th to 20th April
J & K CET	26th April **(Revised)**
Kerala PET	20th & 21st April
Karnataka CET	22nd & 23rd April
NEET	3rd May
COMEDK (Engg.)	10th May
UPSEE	10th May
AMU (Engg.)	31st May **(Revised)**
BITSAT	16th to 25th May
MHT CET	20th to 23rd April **(Revised)**
JEE Advanced	17th May

(b) 

(c) 

(d) 

4. A metal has cubic close packing (*ccp*) arrangement, the layer sequence of which is shown as :



A face diagonal passes through the centre of atom 4 and the centre(s) of which other atom(s)?

(a) 1 (b) 2, 5 (c) 8, 12 (d) 9, 10

5. In the reaction, $2x + B_2H_6 \rightarrow [BH_2(x)_2]^+[BH_4]^-$, the amine(s) x is/are

(a) NH_3 (b) CH_3NH_2

(c) $(CH_3)_2NH$ (d) $(CH_3)_3N$

6. In a closed flask of 5 litre, 1.0 g of H_2 is heated from 300–600 K. Which statement(s) is/are correct?

(a) The rate of collision increases.

(b) The energy of gaseous molecules increases.

(c) The number of moles of the gas increases.

(d) Pressure of the gas increases.

7. Mark out the correct statement(s).

(a) $AlCl_3$ exists as dimers, attaining an octet.

(b) In non-polar solvent $AlCl_3$ undergoes ionisation as $[AlCl_4]^-$ $[AlCl_2]^+$

(c) In water, $AlCl_3$ ionises as $[Al{\cdot}6H_2O]^{3+} + 3Cl^-$.

(d) At low temperature, $AlCl_3$ exists as a close packed lattice of Cl^- with Al^{3+} occupying octahedral holes.

8. Which of the following statements is/are true about the addition polymerisation?

(a) Addition polymerisation occurs between molecules containing double or triple bond.

(b) It takes place in the presence of organic peroxides.

(c) It proceeds via ionic mechanism in the presence of organic peroxides.

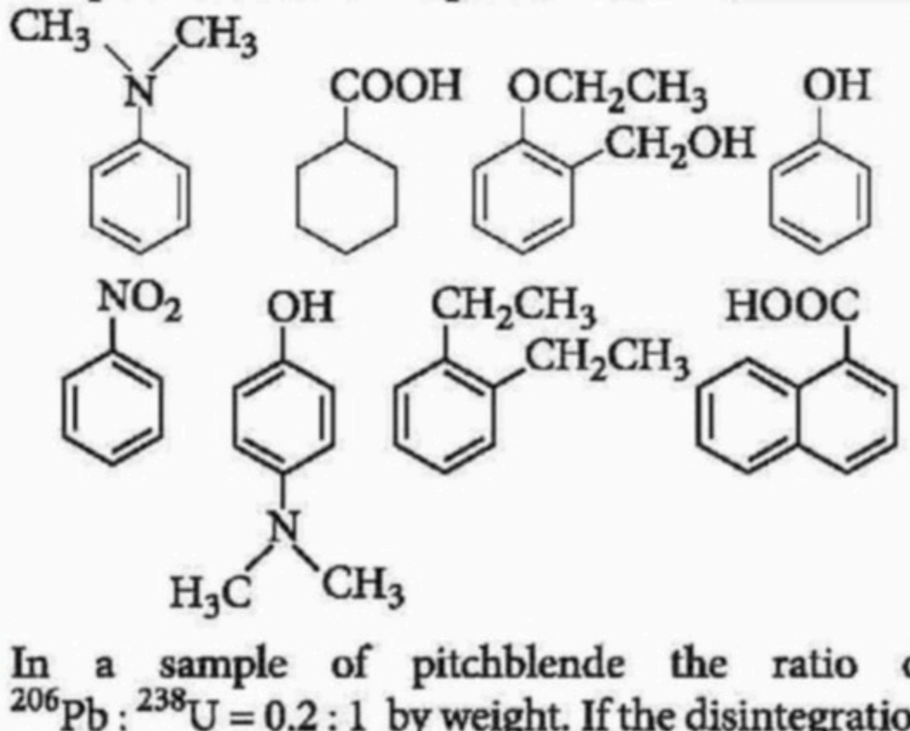
(d) Polythene and polystyrene are addition polymers.

Section 2 (Maximum Marks : 18)

- *This section contains SIX (06) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.*
- *Answer to each question will be evaluated according to the following marking scheme :*
- *Full Marks :* +3 *If ONLY the correct numerical value is entered.*
- *Zero Marks :* 0 *In all other cases.*

9. 1.8 g hydrogen atoms are excited by radiations. The study of spectra indicates that 27% of the atoms are in 3rd energy level, 15% of the atoms are in 2nd energy level and rest of the atoms are in the ground state. Ionisation potential of H is 13.6 eV. The total energy (in kJ) involved when all the atoms return to ground state is _____ .

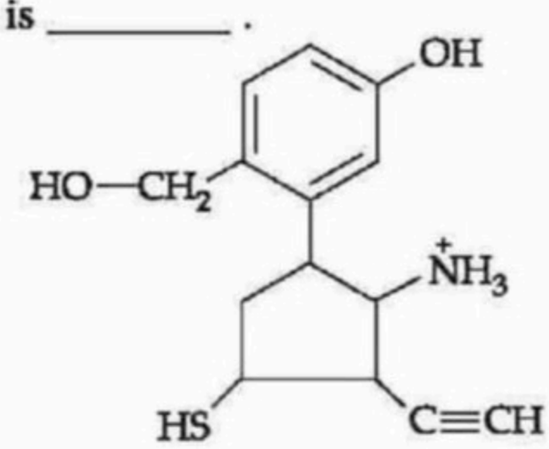
10. Amongst the following, the total number of compounds soluble in aqueous NaOH is _____.



11. In a sample of pitchblende the ratio of $^{206}Pb : {}^{238}U = 0.2 : 1$ by weight. If the disintegration constant of ^{238}U is 1.54×10^{-10} per year and all Pb is supposed to be originated from uranium then, the age of the mineral is 1.35×10^x years. The value of x is _____ .

12. A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. The strength of H_2O_2 solution in terms of volume strength at STP is _____ .

13. Number of hydrogen ions, a single molecule of the following species will lose on treatment with excess of NaOH is _____ .



14. 19 g of molten $SnCl_2$ is electrolysed for some time. Inert electrodes are used. 0.119 g of Sn is deposited at the cathode. No substance is lost during the electrolysis. The ratio of the weights of $SnCl_2$: $SnCl_4$ after electrolysis is $x : y$. The value of $x + y$ is _____.

SECTION 3 (Maximum Marks : 12)

- *This section contains TWO (02) List-Match sets.*
- *Each List-Match set has TWO (02) Multiple Choice Questions.*
- *Each List-Match set has two lists : List-I and List-II.*
- *List-I has Four entries (I), (II), (III) and (IV) and List-II has Six entries (P), (Q), (R), (S), (T) and (U).*
- *FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question.*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks : +3 *If ONLY the option corresponding to the correct combination is chosen.*

Zero Marks : 0 *If none of the options is chosen (i.e. the question is unanswered).*

Negative Marks : –1 *In all other cases.*

Answer Q. 15 and Q. 16 by appropriately matching the lists based on the information given in the paragraph.

Nobel gases neither have a tendency to lose nor to gain electrons and hence do not enter into chemical combination. However after the discovery of $Xe^+[PtF_6]^-$, a large number of xenon compounds mainly with most electronegative elements like fluorine and oxygen have been prepared.

In the following, List-I contains some reactions of xenon compounds and List-II contains products formed from the reactions given in List-I.

	List-I		List-II
I	$XeF_4 + H_2O \xrightarrow[\text{hydrolysis}]{\text{Complete}}$	p.	HF
II	$XeF_6 + H_2O \xrightarrow[\text{hydrolysis}]{\text{Complete}}$	q.	XeO_3
III	$XeOF_4 + H_2O \xrightarrow[\text{hydrolysis}]{\text{Partial}}$	r.	SiF_4
IV	$XeOF_4 + SiO_2 \longrightarrow$	s.	XeO_2F_2

15. Which of the following options has the correct combination considering List-I and List-II?

(a) I → p, q (b) II → p, r

(c) III → r, s (d) IV → p, s

For the **SCIENTIST** in **YOU**

An economical catalyst that can recycle greenhouse gases into fuel

Glaciers are melting, sea levels are rising, cloud forests are dying, and wildlife is scrambling to keep pace and reason can be summed up in two words that is global warming, means, releasing heat-trapping gases popularly known as greenhouse gases. But if you will come to know that these poisonous gases can be converted into the betterment of human civilization?

Yes, it is made possible by scientists. They had taken a major step towards a circular carbon economy by developing a long-lasting, economical catalyst that recycles greenhouse gases into certain constituents that can be used in fuel, hydrogen gas, and other chemicals.

The catalyst, made from inexpensive and abundant nickel, magnesium, and molybdenum, initiates and speeds up the rate of reaction that converts carbon dioxide and methane into hydrogen gas.

The researchers produced nickel-molybdenum nanoparticles under a reductive environment in the presence of a single crystalline magnesium oxide. As the ingredients were heated under reactive gas, the nanoparticles moved on the pristine crystal surface seeking anchoring points. The resulting activated catalyst sealed its own high-energy active sites and permanently fixed the location of the nanoparticles meaning that the nickel-based catalyst will not have a carbon build up, nor will the surface particles bind to one another.

This conversion is called 'dry reforming', where harmful gases, such as carbon dioxide, are processed to produce more useful chemicals that could be refined for use in fuel, plastics, or even pharmaceuticals. It is an effective process, but it previously required rare and expensive metals such as platinum and rhodium to induce a brief and inefficient chemical reaction.

16. Which of the following options has the correct combination considering List-I and List-II?

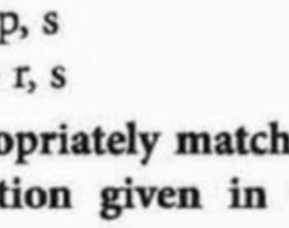
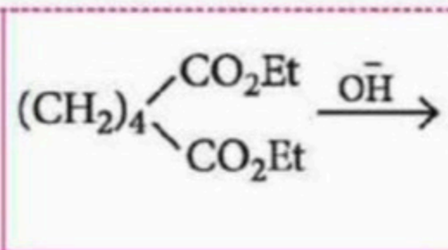
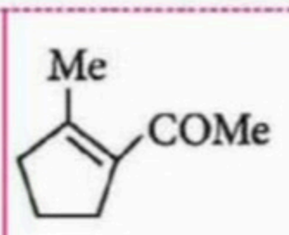
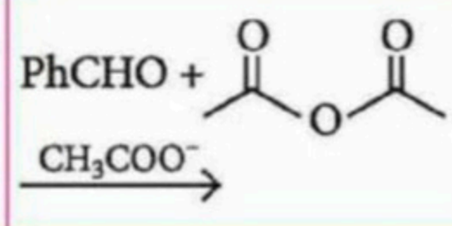
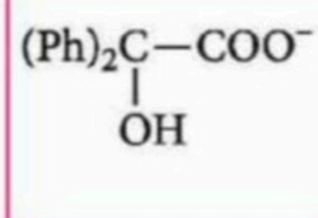
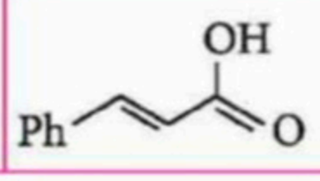
(a) I → p, r (b) II → p, s

(c) III → p, q (d) IV → r, s

Answer Q. 17 and Q. 18 by appropriately matching the lists based on the information given in the paragraph.

A reaction in which two or more molecules combine to form a larger molecule with the simultaneous loss of a small molecule such as water or methanol are called condensation reaction. The term is usually reversed for the reaction in which a new carbon-carbon bond is formed.

List-I includes starting materials and reagents of some chemical reactions. List-II gives structures of compounds that formed from the reactions of List-II.

List-I			List-II
I.	$MeCO(CH_2)_4COMe \xrightarrow[(ii)\ H^+/\Delta]{(i)\ OH^-}$	p.	
II.		q.	
III.		r.	
IV.	$PhCOCOPh \xrightarrow{OH^-}$	s.	

17. Which of the following options has the correct combination considering List-I and List-II?

(a) I → q (b) II → s

(c) III → r (d) IV → p

18. Which of the following options has the correct combination considering List-I and List-II?

(a) I → p (b) II → r

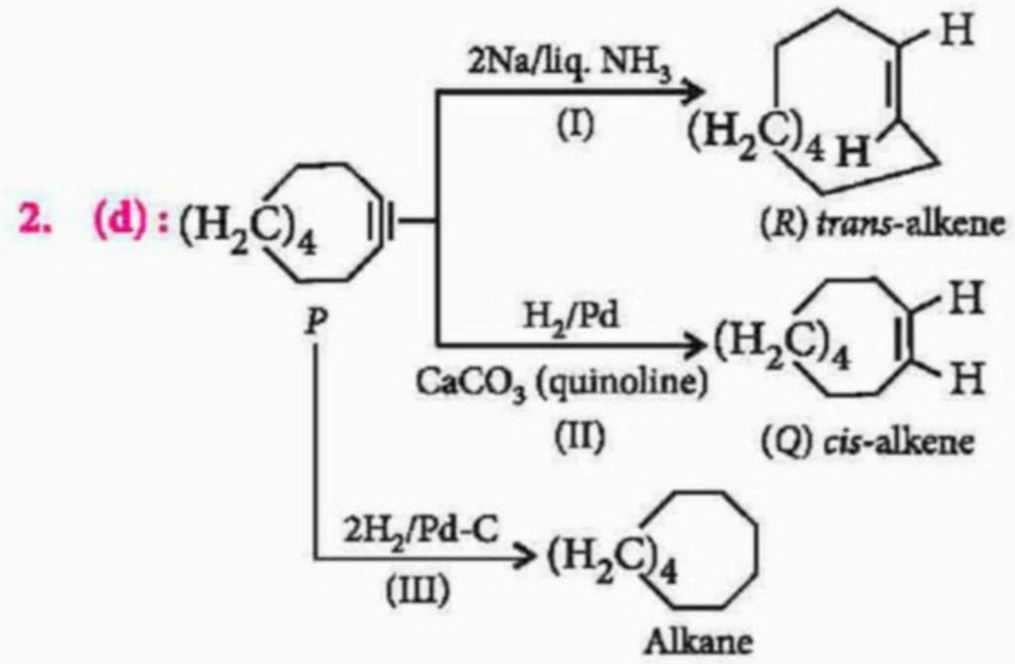
(c) III → s (d) IV → q

SOLUTIONS

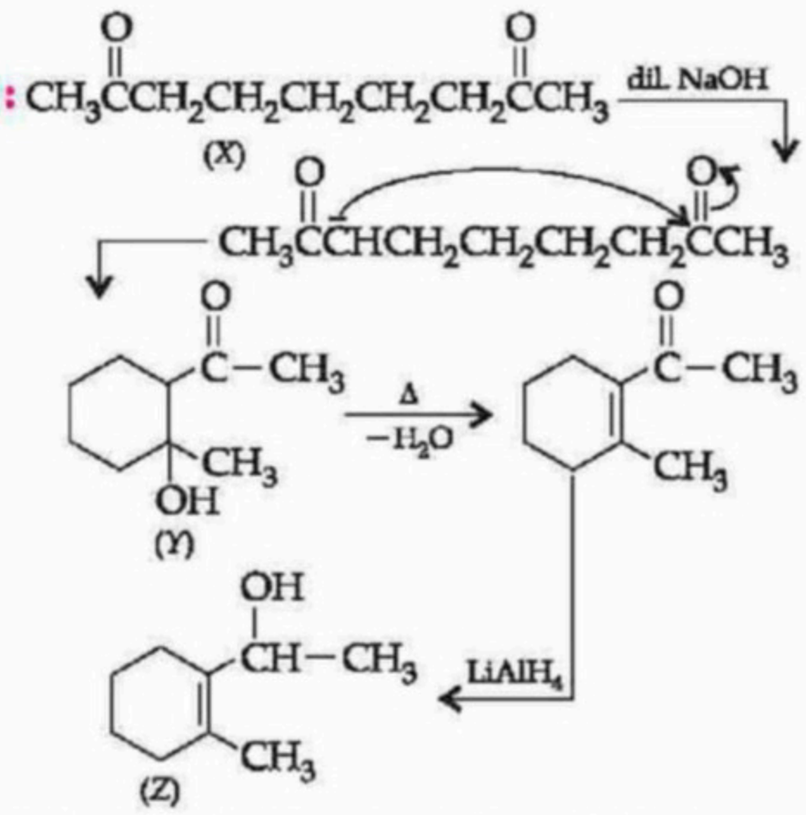
PAPER - I

1. (b) : The F^- ions make the enamel on the teeth much harder by converting hydroxyapatite $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$, the enamel on the surface of the teeth, into much harder fluorapatite, $[3Ca_3(PO_4)_2 \cdot CaF_2]$

2. (d) :



3. (b) :



4. (a) :

$$2CuSO_4 + 4KI \longrightarrow \underset{\text{White ppt.}}{Cu_2I_2} + 2K_2SO_4 + I_2$$

$$HgCl_2 + 2KI \longrightarrow \underset{\text{Orange ppt.}}{HgI_2} + 2KCl$$

$$HgI_2 + 2KI \longrightarrow \underset{\text{Soluble}}{K_2HgI_4}$$

$$Pb(NO_3)_2 + 2KI \longrightarrow \underset{\text{Yellow ppt.}}{PbI_2} + 2KNO_3$$

5. (c,d) : $\Delta H_{PR} = \Delta H_{PQ} + \Delta H_{QS} + \Delta H_{SR}$

$= (-134) + 92 - (-75) = +33 \text{ kJ mol}^{-1}$

$\Delta H_{RQ} = \Delta H_{RS} + \Delta H_{SQ} = (-75) - (+92)$

$= -167 \text{ kJ mol}^{-1} < 0$

Therefore, the enthalpy change for the transformation $R \rightarrow Q$ will be exothermic.

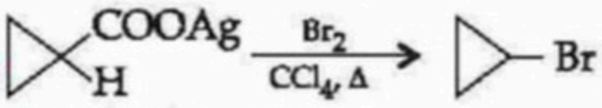
$\Delta H_{SP} = \Delta H_{SQ} + \Delta H_{QP} = -(+92) - (-134) = 42 \text{ kJ mol}^{-1}$

6. (a, b, d) : (a) Electron withdrawing groups favour nucleophilic addition.
(b) Good leaving group favours the process.
(c) Smaller acids are more reactive.
(d) Small alkyl groups in ester favour hydrolysis.

7. (b, d) : The reduction potentials of both Mg and Al are less than that of water. Thus, the ions of both Mg and Al in aqueous solution cannot be reduced and in such a case water will be reduced.

$$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$$

8. (a) :



It is the Hunsdiecker reaction.

9. (a,c) : $\frac{w}{E} = \frac{It}{96500} = \frac{9.65 \times 3600}{96500}$

$= 0.36$ eq. of $Ag^+ = 0.36$ eq. of Cu^{2+}

$= 0.36$ mole of $Ag^+ = 0.18$ mole of Cu^{2+}

Now, Ag will oxidise to Ag^+ and Cu^{2+} will reduce to Cu.

And new $[Ag^+] = 1 + 0.36 = 1.36$ M

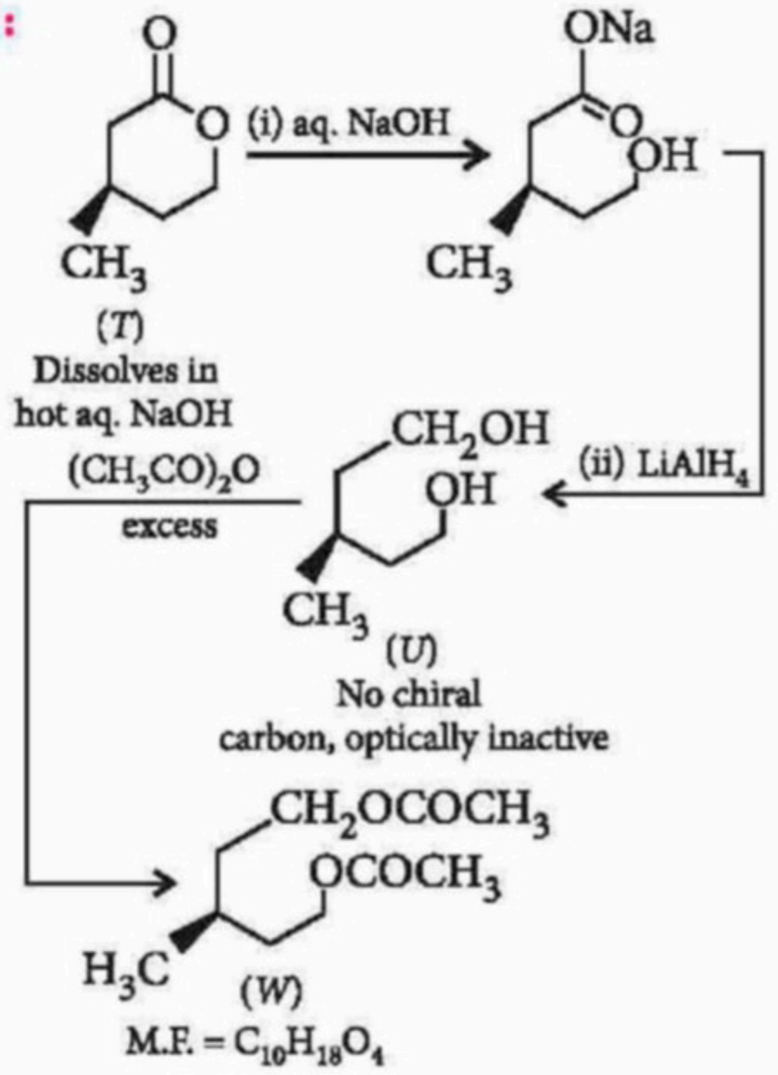
new $[Cu^{2+}] = 1 - 0.18 = 0.82$ M

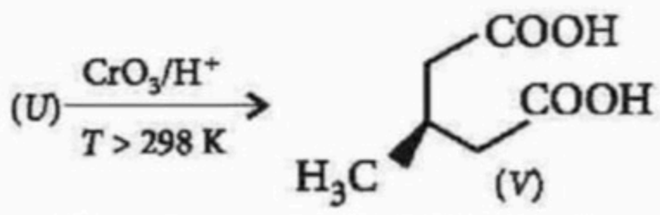
10. (d) : As bond angle decreases, hybridisation continuously changes, *s*-character increases in bonding hybridised orbital and thus, bond length decreases.

CH_4	NH_3	H_2O
no lone pair	1 lone pair	2 lone pairs

Since, *lp-lp* > *lp-bp* > *bp-bp*, therefore, increase in lone pair-lone pair repulsion decreases the bond angle.

11. (a,c,d) :





V gives effervescence with $NaHCO_3$ due to evolution of CO_2.

12. (b,c) : After this hypothetical condition, every orbital can have 3 electrons. As in second orbit, 4 orbitals are there, so total no. of electrons is $4 \times 3 = 12$
Second period would have 12 elements and third period would also have 12 elements.

13. (156.8) : $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

$$n_{FeCr_2O_4} = \frac{224}{224} = 1 \text{ mole}; \quad n_{Na_2CO_3} = \frac{169.6}{106} = 1.6 \text{ mole}$$

Moles of O_2 required for complete consumption of $FeCr_2O_4 = \frac{7}{4} = 1.75$ moles

Moles of O_2 required for complete consumption of $Na_2CO_3 = \frac{1.6 \times 7}{8} = 1.4$ moles

Here, Na_2CO_3 is the limiting reactant.

$\therefore$ Minimum volume of O_2 required $= 1.4 \times 22.4 = 31.36$ L

$\therefore$ Minimum volume of air required $= \frac{100}{20} \times 31.36 = 156.8$ L

14. (86.59) : Given,

$V_1 = 200$ mL $\quad V_2 = ?$
$T_1 = (20 + 273) = 293$ K $\quad T_2 = 273$ K
$P_1 = 755$ mm Hg $\quad P_2 = 760$ mm

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \text{Volume of bulb at NTP} = \frac{200 \times 755}{293} \times \frac{273}{760} = 185.122 \text{ mL}$$

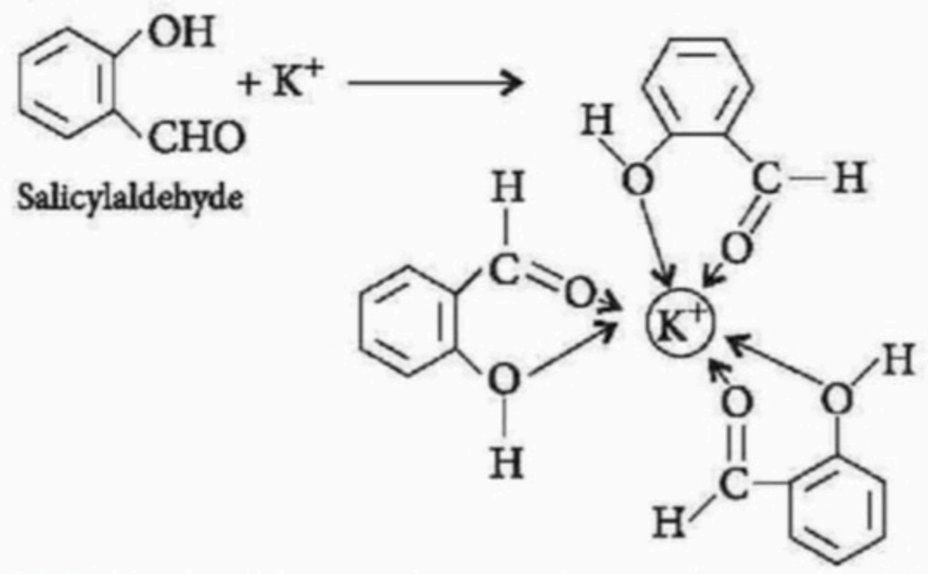
Mass of air $= V_2 \times 0.00129 = 185.122 \times 0.00129 = 0.2388$ g
Mass of empty bulb $= (22.567 - 0.2388) = 22.3282$ g
Mass of vapours $= (22.8617 - 22.3282) = 0.5335$ g
Let the volume of vapour at NTP be *V*.

$$V = \frac{200 \times 755}{393} \times \frac{273}{760} = 138 \text{ mL}$$

$$\text{Mol. mass of the substance} = \frac{\text{Mass of vapours}}{\text{Vol. of vapours at NTP}} \times 22400$$

$$= \frac{0.5335}{138} \times 22400 = 86.59$$

15. (6) : Potassium form 6-coordinated bond with salicylaldehyde.



16. (4) : ala has free —COOH group, gly is optically inactive and will not have free $—NH_2$ group.
Possible structures are :
H_2N—phe—gly—val—ala—COOH
H_2N—phe—val—gly—ala—COOH
H_2N—val—phe—gly—ala—COOH
H_2N—val—gly—phe—ala—COOH

17. (1.17) : $N_2O_4 \rightleftharpoons 2NO_2$
Let *a* moles of N_2O_4 and *b* moles of NO_2 were present in equilibrium mixture.

$$\therefore \quad (a+b) = \frac{PV}{RT} = \frac{753 \times 0.5}{760 \times 0.0821 \times 298} = 0.020 \quad \text{...(i)}$$

$$K_p = \frac{(n_{NO_2})^2}{(n_{N_2O_4})} \times \left[\frac{P}{n_{NO_2} + n_{N_2O_4}}\right]$$

$$\therefore \quad 0.113 = \frac{b^2}{a} \times \left[\frac{753}{760 \times (a+b)}\right]$$

$$\therefore \quad \frac{b^2}{a(a+b)} = 0.114 \qquad \text{...(ii)}$$

By eqs. (i) and (ii)

$$\therefore \quad \frac{b^2}{a} = 0.114 \times 0.020 = 2.3 \times 10^{-3} \qquad \text{...(iii)}$$

$$b^2 = 2.3 \times 10^{-3}\, a = 2.3 \times 10^{-3} \times (0.02 - b)$$

or $\quad b^2 + 0.0023\, b - 4.6 \times 10^{-5} = 0$

$$\therefore \quad b = -\frac{0.0023 \pm \sqrt{(0.0023)^2 + 4 \times 4.6 \times 10^{-5} \times 1}}{2 \times 1}$$

$$= \frac{-0.0023 \pm \sqrt{1.90 \times 10^{-4}}}{2} = 5.73 \times 10^{-3}$$

$\therefore$ From eq. (i), $a = 0.014$

$$2NO_{2(aq)} + 2H_2O_{(l)} \rightarrow HNO_{2\,(aq)} + H_3O^+_{(aq)} + NO_3^-{}_{(aq)}$$

Total NO_2 moles $= 5.73 \times 10^{-3} + 2 \times$ moles of N_2O_4

$$= 5.73 \times 10^{-3} + 2 \times 0.014 = 0.0337$$

$$\underset{0.0337}{2NO_{2(aq)}} + 2H_2O_{(l)} \rightarrow \underset{0}{HNO_{2(aq)}} + \underset{0}{H_3O^+_{(aq)}} + \underset{0}{NO_3^-{}_{(aq)}}$$

$$0 \qquad \frac{0.0337}{2} \qquad \frac{0.0337}{2} \qquad \frac{0.0337}{2}$$

$$[H^+] = \frac{0.0337 \times 1000}{2 \times 250} = 0.0674 \text{ M}$$

Also, $pH = -\log [H^+] = -\log 0.0674 = 1.17$

18. (151.6) : Combustion of $C_xH_{2y}O_y$ can be represented as :

$$C_xH_{2y}O_y + 2xO_2 \longrightarrow xCO_2 + yH_2O$$

The moles of gases obtained after cooling $= x + x = 2x$

$$\therefore \quad 2x = 2.24 \Rightarrow x = \frac{2.24}{2} = 1.12 \text{ litres}$$

Number of moles of CO_2 $(x) = \dfrac{1.12}{22.4} = 0.05$

Moles of H_2O formed $(y) = \dfrac{0.9}{18} = 0.05$

$x : y = 0.05 : 0.05$

$x : y = 1 : 1$

$x = 1$ and $y = 1$

$\therefore$ The empirical formula of the organic compound is (CH_2O).

$$\text{Now,} \quad \frac{p^\circ - p_s}{p^\circ} = \frac{\dfrac{w_A}{M_A}}{\dfrac{w_A}{M_A} + \dfrac{w_B}{M_B}}$$

$$\text{or} \quad \frac{0.104}{17.5} = \frac{\dfrac{50}{M_A}}{\dfrac{50}{M_A} + \dfrac{1000}{18}} \Rightarrow M_A = 151.6$$

Hence, molecular weight of compound = 151.6

PAPER - II

1. (d) : In F_2 molecule, the energy of $\sigma 2p_z$ is less than $\pi 2p_x$ and $\pi 2p_y$.

F_2 molecule follows the order :

$\sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < \sigma 2p_z^2 < (\pi 2p_x^2 = \pi 2p_y^2) < (\pi^* 2p_x^2 = \pi^* 2p_y^2) < \sigma^* 2p_z^0$

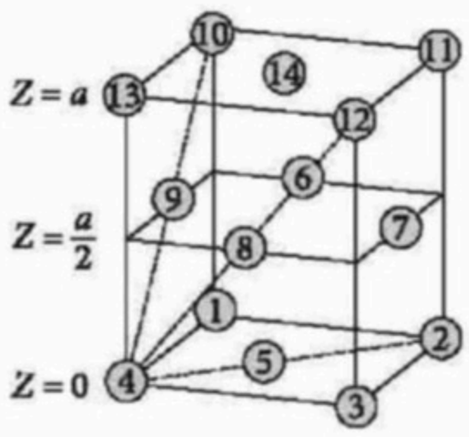
2. (a,c): In graphs I and III, the amount of adsorption decreases with increase of temperature and increases with increase of pressure. Hence, they represent physisorption.

In graph II, amount of adsorption increases with increase in temperature. Hence, it represents chemisorption. Graph IV shows the formation of a chemical bond. Hence, it again represents chemisorption.

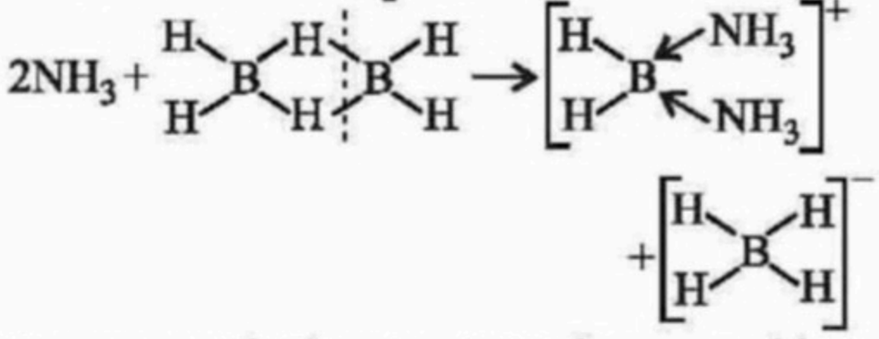
Thus, (a) and (c) are correct while (b) and (d) are incorrect.

3. (c) : Compound (c) shows optical inactivity as there is no chiral C-atom and a plane of symmetry is present in the compound.

4. (b,c,d) : $Z = 0$ forms the bottom layer, $Z = a/2$ forms second layer above it and $Z = a$ forms the third layer. Atoms 5, 6, 7, 8, 9 and 14 are present at the face centres. Atoms 1, 2, 3, 4, 10, 11, 12 and 13 are present at the corners. 4, 5, 2 form one face diagonal 4, 9, 10 form another face diagonal; 4, 8, 12 form one more face diagonal.



5. (a,b,c) : B_2H_6 reacts with NH_3, 1° and 2° amines and forms ionic compounds.



However, with 3° amine, B_2H_6 forms an adduct.

$$B_2H_6 + 2N(CH_3)_3 \longrightarrow 2(CH_3)_3N \rightarrow BH_3$$

6. (a,b,d) : As the temperature increases number of collisions increases, hence pressure of gas molecules

increases. The energy of gas molecules also increases due to increase of temperature.

7. (a,c,d) : In non-polar solvent, $AlCl_3$ retains its dimeric form.

8. (a,b,d) : Addition reactions (electrophilic or free radical) are common for the alkenes and alkynes which are initiated by ions or free radicals.

9. (832.50) : 1 g H contains $= 6.023 \times 10^{23}$ atoms

$\therefore$ 1.8 g H contains $= 6.023 \times 10^{23} \times 1.8$

$= 10.84 \times 10^{23}$ atoms

No. of atoms in 3rd shell $= \dfrac{10.84 \times 10^{23} \times 27}{100}$

$= 292.68 \times 10^{21}$ atoms

No. of atoms in 2nd shell $= \dfrac{10.84 \times 10^{23} \times 15}{100}$

$= 162.6 \times 10^{21}$ atoms

When all the atoms return to 1st shell, then

(i) $E'_{(3 \to 1)} = (E_3 - E_1) \times 292.68 \times 10^{21}$

$= \left(-\dfrac{13.6}{9} + 13.6\right) \times 1.602 \times 10^{-19} \times 292.68 \times 10^{21}$

$= 5.668 \times 10^5$ J

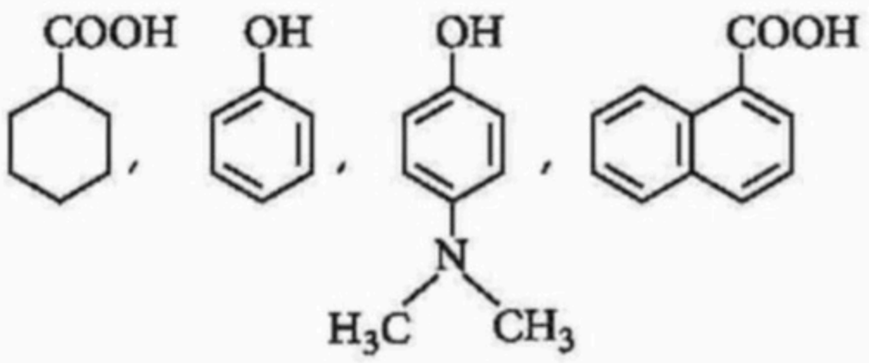
(i) $E''_{(2 \to 1)} = (E_2 - E_1) \times 162.6 \times 10^{21}$

$= \left(-\dfrac{13.6}{4} + 13.6\right) \times 1.602 \times 10^{-19} \times 162.6 \times 10^{21}$

$= 2.657 \times 10^5$ J

$\therefore$ $E = E' + E'' = 5.668 \times 10^5 + 2.657 \times 10^5$ J $= 832.50$ kJ

10. (4) : Out of the given compounds, those soluble in aq. NaOH are :



11. (9) :

	$^{238}U \longrightarrow$	^{206}Pb
Initial moles :	a	0
Moles after time t :	$(a - x)$	x

$$\frac{\text{Wt. of } ^{206}Pb}{\text{Wt. of } ^{238}U} = \frac{0.2}{1}$$

$$\therefore \quad \frac{\text{Moles of } ^{206}Pb}{\text{Moles of } ^{238}U} = \frac{0.2/206}{1/238} = \frac{0.231}{1}$$

or $\dfrac{x}{a-x} = 0.231$

On adding 1 to both sides,

$$1 + \frac{x}{a-x} = 0.231 + 1 \Rightarrow \frac{a}{a-x} = 1.231$$

Now, $\lambda = \dfrac{2.303}{t} \log \dfrac{a}{a-x}$

$\Rightarrow$ $1.54 \times 10^{-10} = \dfrac{2.303}{t} \log 1.231$

$t = 1.35 \times 10^9$ years

$\therefore$ $x = 9$

12. (4.48) : $\underset{34\text{ g}}{H_2O_2} + H_2SO_4 + 2KI \longrightarrow \underset{254\text{ g}}{I_2} + K_2SO_4 + 2H_2O$

254 g of I_2 is produced by 34 g H_2O_2

$\therefore$ 0.508 g of I_2 will be produced by $\dfrac{34}{254} \times 0.508$ g

$= 0.068$ g H_2O_2

Hence, 5 mL of H_2O_2 solution contains $H_2O_2 = 0.068$ g

$\therefore$ 1 mL of H_2O_2 solution contains $H_2O_2 = \dfrac{0.068}{5}$ g

For volume strength of H_2O_2,

$\underset{2 \times 34 = 68\text{ g}}{2H_2O_2} \longrightarrow 2H_2O + \underset{22.4\text{ L at STP}}{O_2}$

68 g of H_2O_2 produces O_2 at NTP $= 22.4$ L

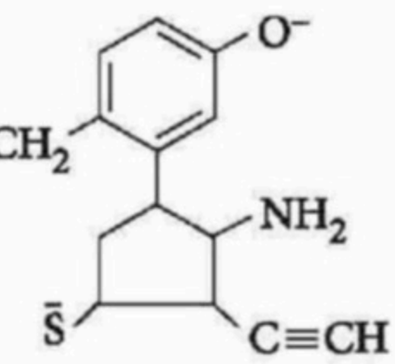
$\therefore$ 1 mL (*i.e.*, $\dfrac{0.068}{5}$ g) of H_2O_2 produces O_2 at NTP

$= \dfrac{22400}{68} \times \dfrac{0.068}{5} = 4.48$ mL

i.e., the volume strength of H_2O_2 solution is 4.48.

("Volume strength" indicates the mL of O_2 at STP obtained from 1 mL of H_2O_2 solution.)

13. (3) :



H_2O is a stronger acid than $RC{\equiv}CH$ and RCH_2OH. Thermodynamics supports the formation of weaker acid.

14. (72.34) : $\underset{2\{119 + (2 \times 35.5)\} = 380}{2SnCl_2} \longrightarrow \underset{119}{Sn} + \underset{119 + (4 \times 35.5) = 261}{SnCl_4}$

119 g Sn is deposited on decomposition of 380 g $SnCl_2$.

$\therefore$ 0.119 g of Sn is deposited on decomposition of

$\frac{380}{119} \times 0.119\ g = 0.380\ g\ SnCl_2$

380 g of $SnCl_2$ decomposes to give $SnCl_4 = 261$ g

$\therefore$ 0.380 g $SnCl_2$ decomposes to give $SnCl_4$

$= \frac{261}{380} \times 0.380\ g = 0.261\ g$

Weight of $SnCl_2$ left after decomposition

$= 19.000 - 0.380\ g = 18.620\ g$

Weight of $SnCl_4$ formed = 0.261 g

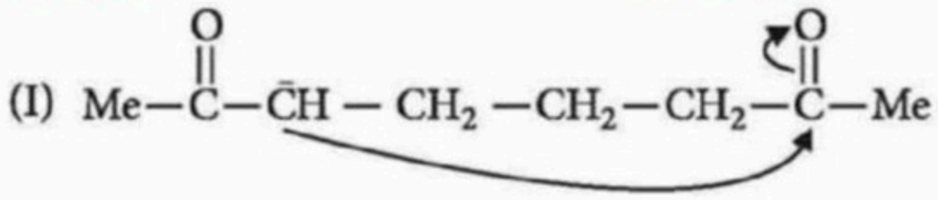
Ratio of $SnCl_2 : SnCl_4$ is 18.620 : 0.261 or 71.34 : 1

$\Rightarrow$ 71.34 + 1 = 72.34

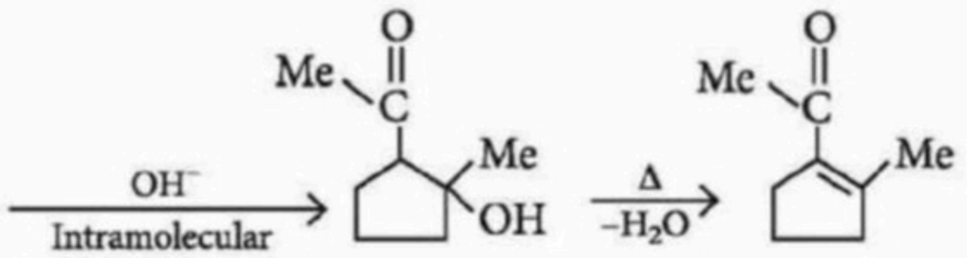
15. (c) : $XeF_4 + H_2O \xrightarrow[\text{hydrolysis}]{\text{complete}} 4Xe + 2XeO_3 + 24HF + 3O_2$

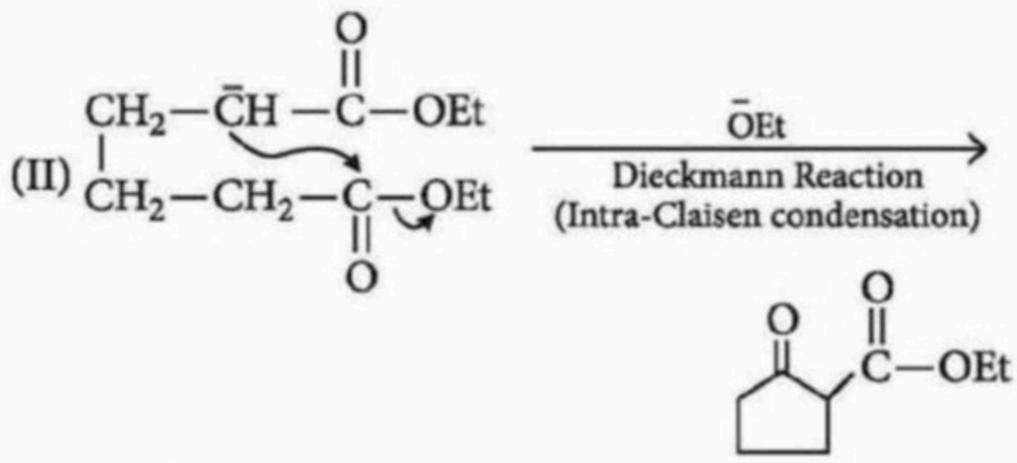
16. (d) : $2XeOF_4 + SiO_2 \longrightarrow 2XeO_2F_2 + SiF_4$

17. (a)

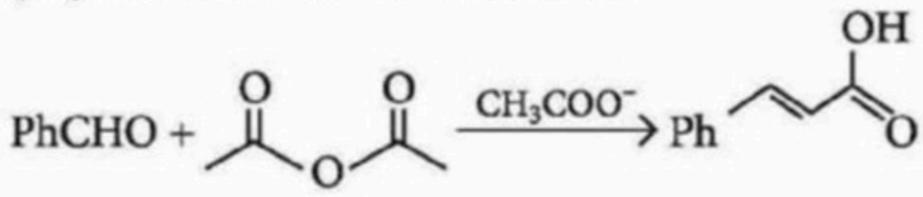
(I) 

18. (c)

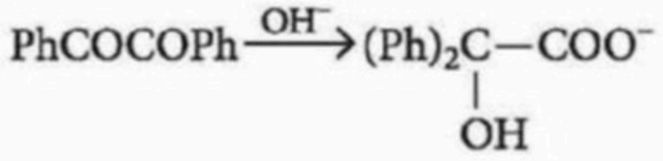


(II) 

(III) Perkin condensation reaction.

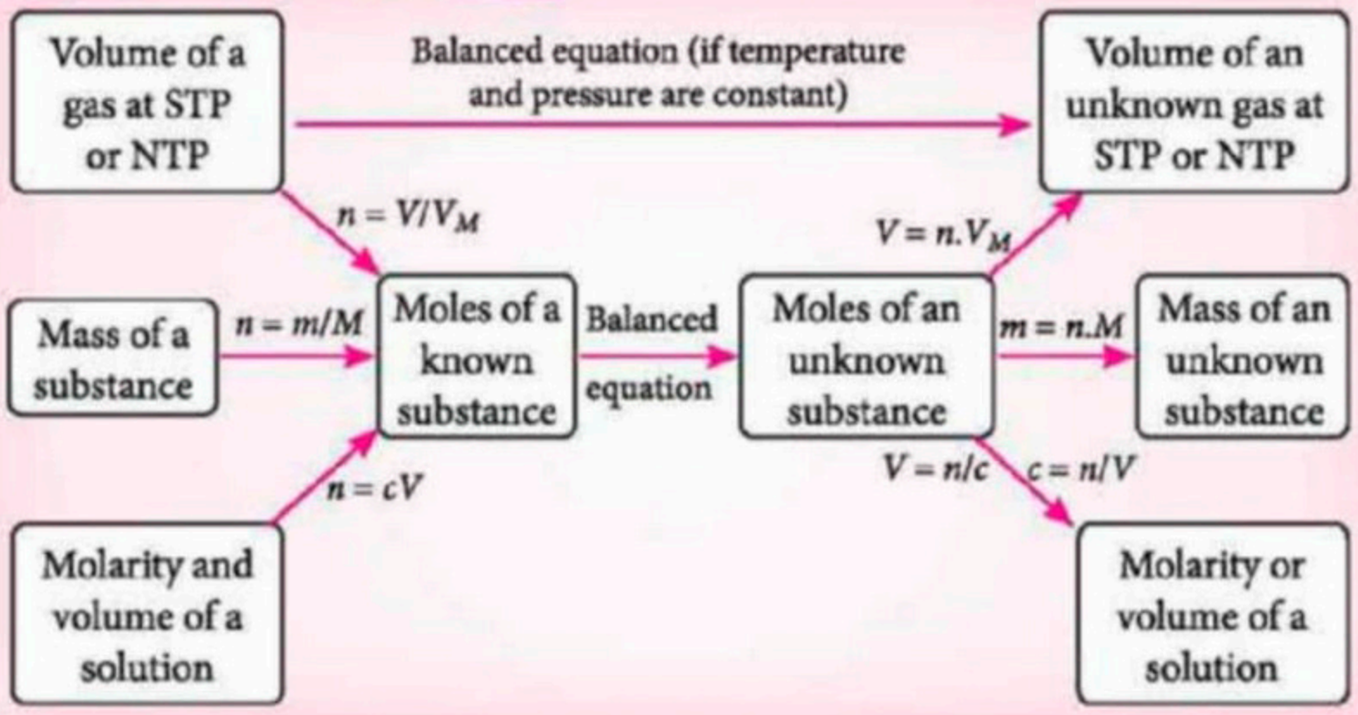


(IV) Benzil-Benzilic acid rearrangement.



CONCEPT MAP

Moles Calculation



Enzymatic Catalysed Reactions

Enzymes	Reactions which are catalysed.
Amylase	Starch → n × Glucose
Maltase	Maltose → 2 × Glucose
Lactase	Lactose → Glucose + galactose
Invertase	Sucrose → Glucose + fructose
Pepsin	Proteins → Amino acid
Trypsin	Polypeptides → Amino acid
Nuclease	DNA, RNA → Nucleotides
Urease	Urea → $NH_3 + CO_2$
Carbonic anhydrase	$H_2CO_3 \rightarrow CO_2 + H_2O$

Relations between Different Periodic Properties

S. No.	Ionisation potential	Electron affinity	Electronegativity	Metallic character	Basic character	Acidic character
1.	$\propto \frac{1}{\text{Atomic size}}$	$\propto \frac{1}{\text{Atomic size}}$	$\propto \frac{1}{\text{Atomic size}}$	$\propto$ Atomic size	$\propto$ Atomic size	$\propto \frac{1}{\text{Atomic size}}$
2.	$\propto$ Effective nuclear charge	$\propto$ Effective nuclear charge	$\propto$ Effective nuclear charge	$\propto \frac{1}{\text{Ionisation potential}}$	$\propto \frac{1}{\text{Ionisation potential}}$	$\propto$ Effective nuclear charge
3.	$\propto \frac{1}{\text{Shielding effect}}$	$\propto \frac{1}{\text{Shielding effect}}$	$\propto$ Ionisation potential	$\propto \frac{1}{\text{Effective nuclear charge}}$	$\propto \frac{1}{\text{Electronegativity}}$	$\propto$ Ionisation potential
4.	$\propto$ Stability of fully and half-filled orbitals	$\propto$ 1/Stability of fully and half-filled orbitals	$\propto$ s-character in hybrid orbitals	$\propto \frac{1}{\text{Electronegativity}}$	$\propto \frac{1}{\text{Oxidation number}}$	$\propto$ Electronegativity
5.	$\propto$ Penetrating power	$\propto$ Oxidation number	$\propto \frac{1}{p\text{-character in hybrid orbitals}}$	$\propto$ Oxidation number	$\propto$ Metallic character	$\propto$ Oxidation number
6.	$\propto$ Oxidation number		$\propto$ Oxidation number		$\propto \frac{1}{\text{Effective nuclear charge}}$	$\propto \frac{1}{\text{Metallic charge}}$

Comparative Oxidising Nature of $KMnO_4$, $K_2Cr_2O_7$ and H_2O_2

In Acidic Medium

$2KMnO_4 + 3H_2SO_{4(dil.)} \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$

or $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$

or $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

In Neutral Medium

$2KMnO_4 + H_2O \rightarrow 2KOH + 2MnO_2 + 3[O]$

or $MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$

$\therefore$ Eq. weight of $KMnO_4$

$$= \frac{\text{Mol. weight}}{3} = \frac{158}{3} = 52.67$$

It oxidises H_2S to S.

$2KMnO_4 + 3H_2S \rightarrow 3S + 2KOH + 2H_2O + 2MnO_2$

It oxidises thiosulphate to sulphate and sulphur

$2KMnO_4 + 3Na_2S_2O_3 + H_2O \rightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH + 3S$

In Alkaline Medium

$2KMnO_4 + H_2O \longrightarrow 2MnO_2 + 2KOH + 3[O]$

$K_2Cr_2O_7 + 2KOH \rightarrow 2K_2CrO_4 + H_2O$

Orange → Yellow

$K_2Cr_2O_7$, exists as K_2CrO_4 in basic medium so it does not act as oxidising agent in basic medium.

$H_2O_2 + 2e^- \rightarrow 2OH^-$

PORTANT FACTS FOR LAST MINUTE PREPARATION

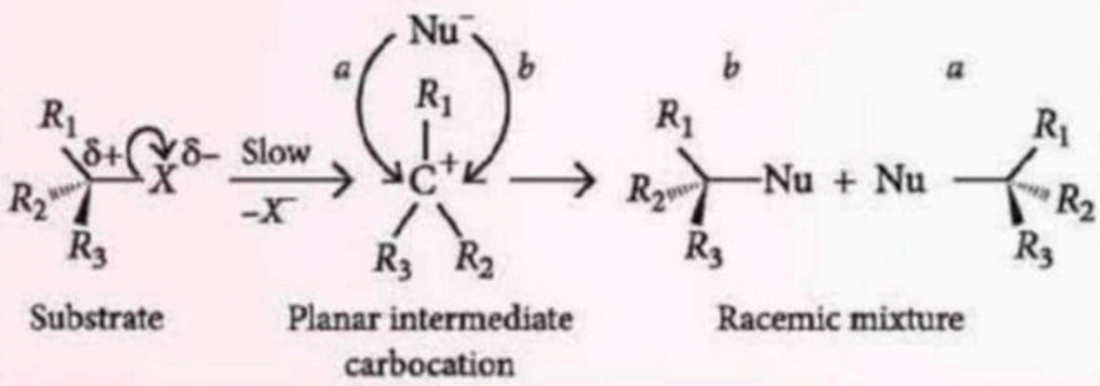
Important Orders of Organic Species

- **-*I*-effect :** $R_3\overset{+}{N}- > -NO_2 > -SO_2R > -CN > -COOH > -F > -Cl > -Br > -I > -OR > -COR > -OH > -C_6H_5 > -CH=CH_2 > -H$
- **+*I*-effect :** $(CH_3)_3C- > (CH_3)_2CH- > CH_3CH_2- > CH_3- > -T > -D > -H$
- **+*R*-effect :** $-Cl, -Br, -I, -NH_2, -NHR, -NR_2, -NHCOR, -OH, -OR, -SR, -SH, -OCH_3, -OCOR$
- **-*R*-effect :** $-NO_2, -CN, \rangle C=O, -CHO, -COOH, -COOR$
- Stability of free radicals $\propto +I\text{-effect} \propto \frac{1}{-I\text{-effect}} \propto +R\text{-effect} \propto \frac{1}{-R\text{-effect}}$; $Ph_3\dot{C} > Ph_2\dot{C}H > 3^\circ > Ph\dot{C}H_2 > 2^\circ > 1^\circ > \dot{C}H_3 > CH_2=\dot{C}H$
- Stability of carbocations $\propto +I\text{-effect} \propto \frac{1}{-I\text{-effect}} \propto +R\text{-effect} \propto \frac{1}{-R\text{-effect}}$; $Ph_3\overset{+}{C} > Ph_2\overset{+}{C}H > 3^\circ > Ph\overset{+}{C}H_2 > 2^\circ > 1^\circ > \overset{+}{C}H_3$
- Stability of carbanions $\propto -I\text{-effect} \propto \frac{1}{+I\text{-effect}} \propto -R\text{-effect} \propto \frac{1}{+R\text{-effect}}$; $Ph_3\bar{C} > Ph_2\bar{C}H > Ph\bar{C}H_2 > \bar{C}H_3 > 1^\circ > 2^\circ > 3^\circ$

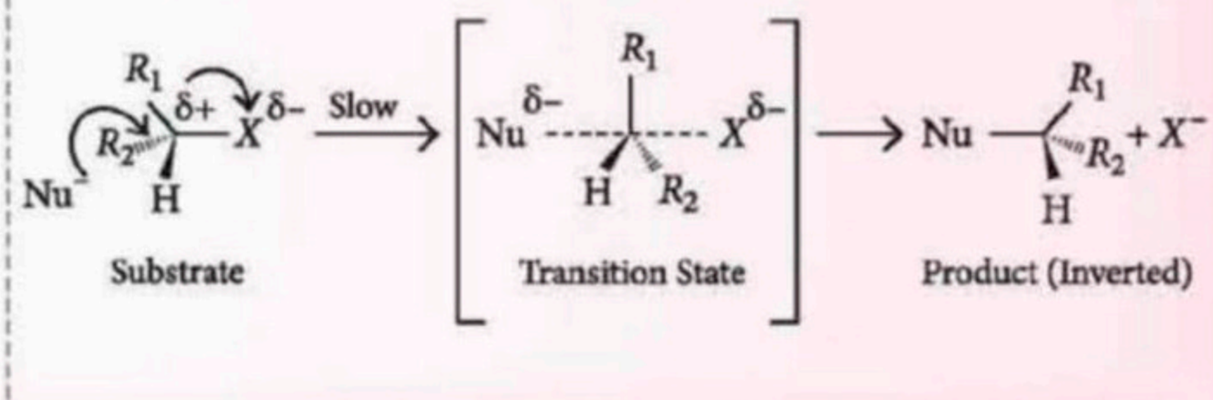
Elimination *vs* Substitution Reactions

Nucleophilic Substitution Reactions

S_N1 (Racemisation)



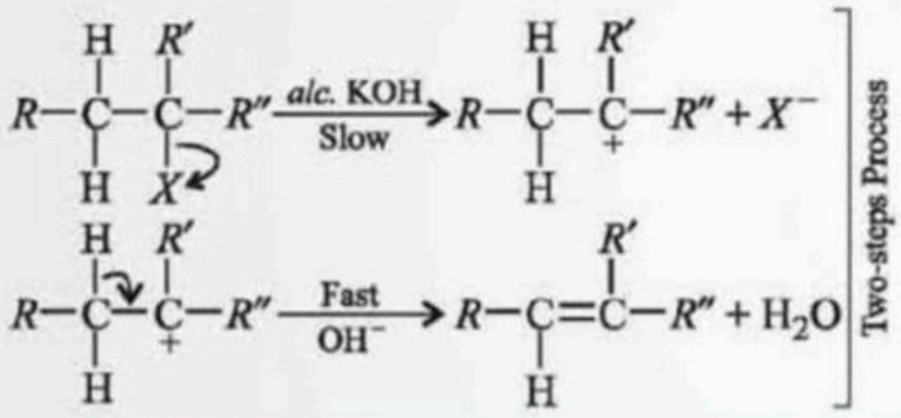
S_N2 (Inversion of Configuration)



Elimination Reactions

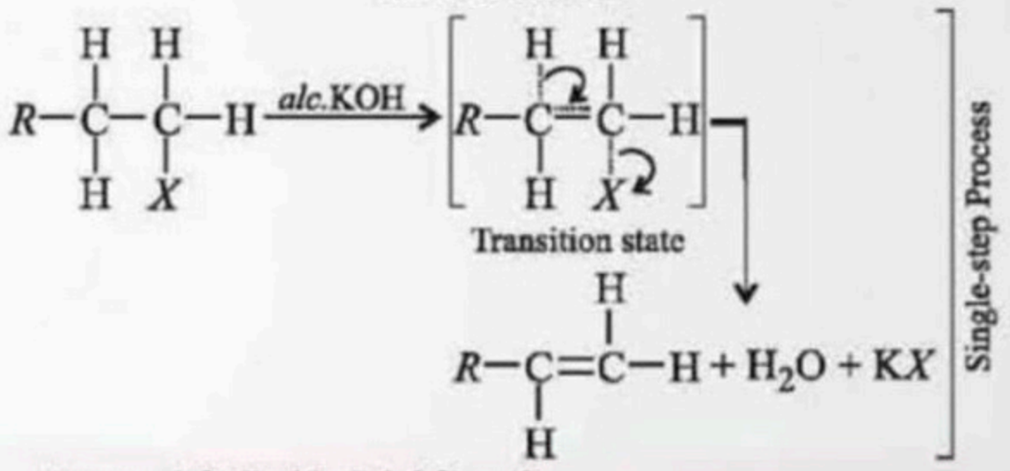
Alkyl halides undergo β-elimination reaction in the presence of potassium hydroxide in ethanol (high temperature) to yield alkenes.

E1 mechanism



Rate = k [Alkyl halide]

E2 mechanism



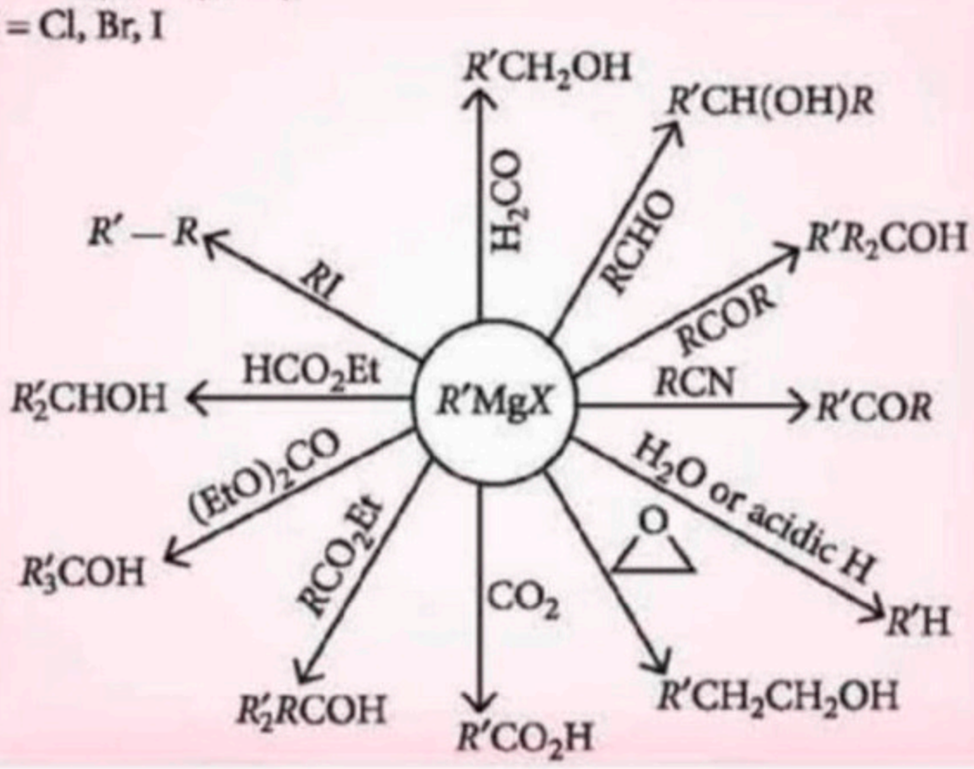
Rate = k [Alkyl halide] [base]

Reducing Nature of Different Reagents

Conversions	$LiAlH_4$/ether	$NaBH_4/C_2H_5OH$	H_2/Metal	B_2H_6/THF
$-CHO \rightarrow -CH_2OH$	✓	✓	✓	✓
$\rangle CO \rightarrow \rangle CHOH$	✓	✓	✓	✓
$-COOH \rightarrow -CH_2OH$	✓	×	×	✓
$-COCl \rightarrow -CH_2OH$	✓	✓	×	✓
$(RCO)_2O \rightarrow RCH_2OH$	✓	×	✓	✓
$-COOR \rightarrow -CH_2OH$	✓	×	✓	✓

Applications of Grignard Reagent

R' = alkyl, vinyl, aryl
X = Cl, Br, I



Rank Enhancer

This column is specially designed to make your concepts crystal clear.

METAL CARBONYLS

Compounds of metals with CO (carbon monoxide) as a ligand are called metal carbonyls.

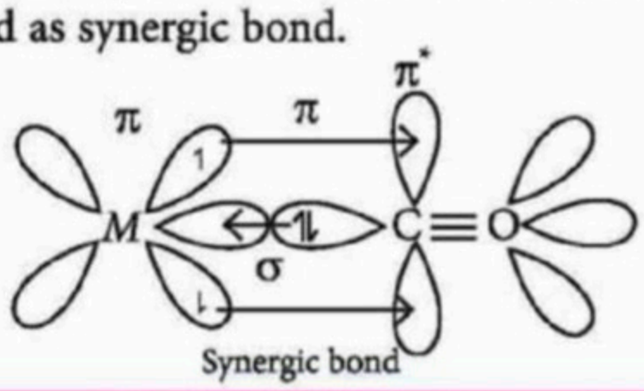
Classification Based on Number of Metals :

	Monomeric metal carbonyls		Polymeric metal carbonyls
1.	Those metal carbonyls which contain only one metal atom per molecule are called monomeric metal carbonyls.	1.	Metal carbonyls which contain two or more than two metal atoms per molecule are called polymeric metal carbonyls.
2.	More volatile	2.	Less volatile
3.	Either colourless or light coloured	3.	Deep coloured
4.	Examples: (1) $Ni(CO)_4$ (2) $Fe(CO)_5$ (3) $Cr(CO)_6$ (4) $V(CO)_6$	4.	Examples: (1) $Mn_2(CO)_{10}$ (2) $Co_2(CO)_8$

Bonding in Metal Carbonyls

Metal-carbon bond in metal carbonyls possesses both *s*- and *p*-character and they form two types of bonds :

- **σ-Bond :** It is formed by donation of lone pair of electrons from carbonyl carbon into a vacant hybrid *d*-orbital of metal.
- **π-Bond :** It is formed by sidewise overlapping of filled unhybrid *d*-orbital of metal with vacant π*-orbital of carbon of CO.
- During bonds formation, carbon acts as σ donor and π-acceptor. These two interactions combinely called as synergic bond.



Synergic bond

Consequences of Synergic Bond :

- **Bond energy of CO :** As metal-carbon π-bonding increases, bond between C and O weakens.

(a) If same metal with different +ve oxidation number then

+ve oxidation number of metal increases
⇓
its donating tendency decreases
⇓
$(M - C)$ π-bond weakens
⇓
(C — O) bond becomes stronger
⇓
∴ Bond energy of C — O Bond ∝ oxidation number of metal

(b) If isoelectronic : In anionic complexes, metal has a greater electron density to be dispersed, $M-C$, π bond strength increases, σ bond strength between C — O decreases *i.e.*,

−ve charge on complex increases
⇓
more electron density on metal
⇓
$M - C$ π-bond becomes stronger
⇓
C — O bond becomes weaker
⇓
∴ Bond energy of C — O bond ∝ $\frac{1}{\text{−ve charge on complex}}$

Example : Decreasing order of bond energy of C—O bond :
$[Ni(CO)_4] > [Co(CO)_4]^- > [Fe(CO)_4]^{2-}$

- **Bond order :** We know, bond energy is directly proportional to bond order, we can use above concept for bond order.

Metal–carbon π bond strength increases
⇓
Carbon-oxygen bond strength decreases
⇓
Carbon-oxygen bond order decreases

By K. Vijay Bhasker, Senior faculty at Sri Chaitanya Educational Institution, Visakhapatnam

- **Bond length :** As we know bond length inversely proportional to bond energy and bond order.

Example :

In $[V(CO)_5]^{3-}$ $[Cr(CO)_5]^{2-}$ $[Mn(CO)_5]^{-}$ ⟶

Metal-carbon bond strength decreases
Carbon-oxygen bond strength increases
Carbon-oxygen bond order increases
Carbon-oxygen bond length decreases

Use of EAN Rule to Identify Oxidising Nature :

(1) EAN of V in $[V(CO)_6]$

$\Rightarrow$ At. No. + C.No. (2) – Ox. No.

$= 23 + 6(2) - 0 = 35$

To get next inert gas EAN, it gains an electron and reduces, acts as an oxidising agent.

$[V(CO)_6] + e^- \longrightarrow [V(CO)_6]^-$

EAN = 35 EAN = 36

(2) EAN of Co in $[Co(CO)_4]$

$\Rightarrow$ At. No. + C.No. (2) – Ox. No.

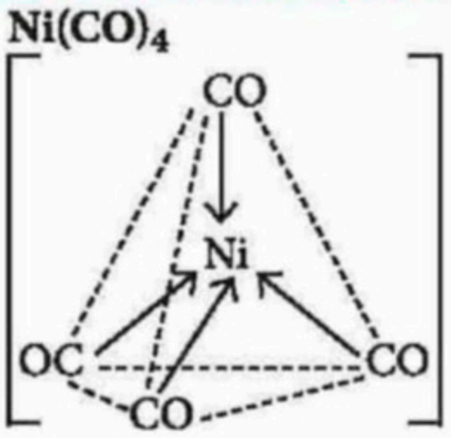
$\Rightarrow 27 + 4(2) - 0 \Rightarrow 35$

To get next inert gas EAN, it dimerises and acts as an oxidising agent.

$2Co(CO)_4 \longrightarrow Co_2(CO)_8$

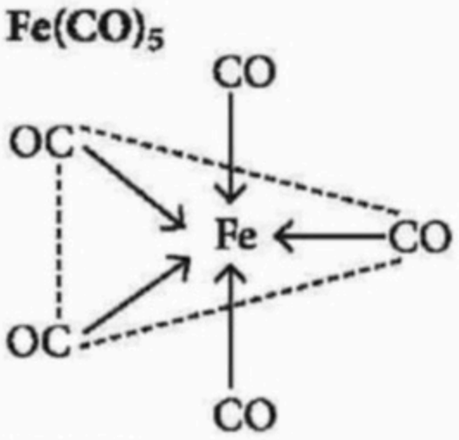
Structures of Some Important Carbonyl Compounds :

1. **$Ni(CO)_4$**



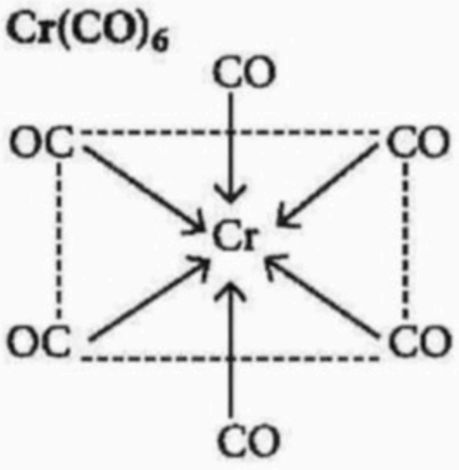
sp^3 hybridisation
Tetrahedral
EAN = 28 + 4(2) + 0
EAN = 36

2. **$Fe(CO)_5$**



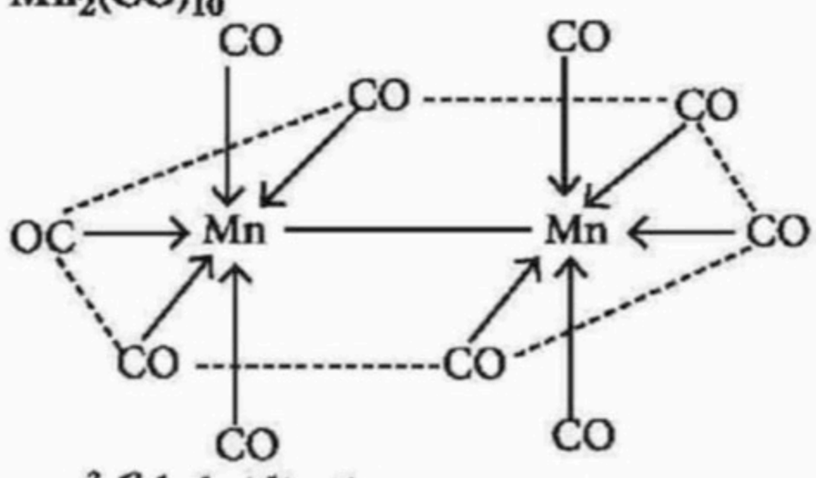
sp^3d hybridisation
Trigonal bipyramidal
EAN = 26 + 5(2) + 0
EAN = 36

3. **$Cr(CO)_6$**



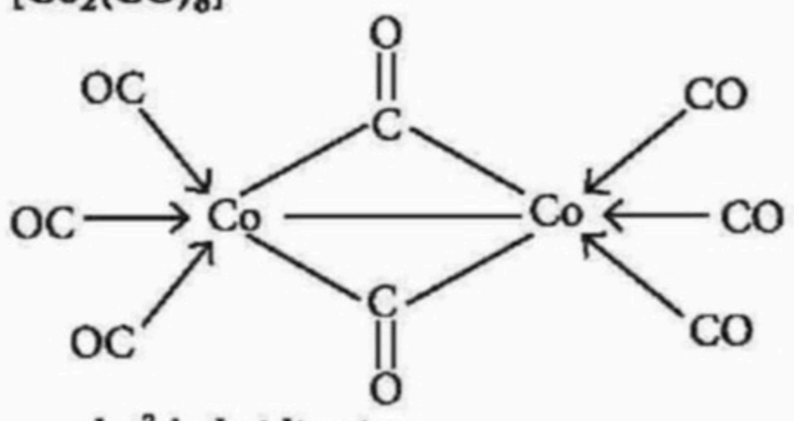
sp^3d^2 hybridisation
octahedral or Square bipyramidal
EAN = 24 + 6(2) + 0
EAN = 36

4. **$Mn_2(CO)_{10}$**



sp^3d^2 hybridisation
EAN = 25 + 5(2) + 1 = 36
(Metal-metal bond)

5. **$[Co_2(CO)_8]$**



dsp^3 hybridisation
EAN = 27 + 3(2) + 2 + 1 = 36
(Co–C bond) (Co–Co bond)

PROBLEMS

1. Which of the following is/are paramagnetic?
(a) $[V(CO)_6]$ (b) $[Cr(CO)_6]$
(c) $[Co_2(CO)_8]$ (d) $[Fe(CO)_5]$

2. In which of the following metal-carbonyl compounds, metal-carbon bond order is lowest?
(a) $[Fe(CO)_5]$ (b) $[Cr(CO)_6]$
(c) $[Mn(CO)_6]^+$ (d) $[V(CO)_6]^-$

3. Oxidation number of Co in $Na[Co(CO)_4]$ is
(a) 0 (b) +1 (c) –1 (d) +3

4. Bond between Cr and C in $Cr(CO)_6$ possesses
(a) σ character (b) π character
(c) ionic character (d) both (a) and (b).

5. Which of the following species is not expected to be a ligand?
(a) NO (b) NH_4^+
(c) $NH_2CH_2CH_2NH_2$ (d) CO

6. Correct order of C — O bond strength is
(a) $[Ti(CO)_6]^{2-} > [V(CO)_6]^- > [Cr(CO)_6] > [Mn(CO)_6]^+$
(b) $[Mn(CO)_6]^+ > [Cr(CO)_6] > [V(CO)_6]^- > [Ti(CO)_6]^{2-}$
(c) $[V(CO)_6]^- > [Ti(CO)_6]^{2-} > [Mn(CO)_6]^+ > [Cr(CO)_6]$
(d) $[Ti(CO)_6]^{2-} > [V(CO)_6]^- > [Mn(CO)_6]^+ > [Cr(CO)_6]$

7. What is the sum of bond order of Fe — C bond and C — O bond in $Fe(CO)_5$?

(a) $2\frac{1}{2}$ (b) 3

(c) 4 (d) $3\frac{1}{2}$

8. $Co(CO)_4$ attains stability by

(a) oxidation of Co (b) reduction of Co

(c) dimerisation (d) both (b) and (c).

9. EAN of $W(CO)_6$ is

(a) 36 (b) 54 (c) 86 (d) 84

10. Stable metal carbonyl among the following is/are

$Cr(CO)_6$ (I) $Mn(CO)_6$ (II) $Fe(CO)_5$ (III)

(a) I and II (b) I and III

(c) II only (d) II and III.

SOLUTIONS

1. (a) : EAN = At.No. + C.No. (2) – Ox. No.

= 23 + 6(2) – 0 = 35

As it contains odd number of electrons, it is paramagnetic.

2. (c) : Due to –ve charge, π-bond strength increases and metal-carbon bond weakens and bond order is lowest.

3. (c) : Na + Co + 4(CO) = 0

+1 + Co + 4(0) = 0

Co = –1

4. (d) : In metal carbonyls, metal-carbon bond contains both σ and π bond characteristics.

5. (b) : NH_4^+ does not contain lone pair to act as a ligand.

6. (b) : More –ve charge density on metal, less is C — O bond strength.

7. (c) : Bond order between metal-carbon = 1

Bond order between carbon-oxygen = 3

Sum of bond orders = 4

8. (d) : EAN of $Co(CO)_4$ is 35. Hence, it dimerises and undergoes reduction of Co, acts as an oxidising agent.

9. (c) : EAN = At. No. + C. No. (2) – Ox. No.

= 74 + 6(2) – 0 = 86

10. (b) : EAN of $Mn(CO)_6$ is not equal to inert gas EAN. Hence, it is unstable.

Scientist Who Made Us Proud

Karl Waldemar Ziegler was a German chemist who won the Nobel Prize in Chemistry in 1963, with Giulio Natta, for work on polymers. He is also known for his work involving free-radicals, multi-membered rings, and organometallic compounds, as well as the development of Ziegler–Natta catalyst. One of many awards Ziegler received was the Werner von Siemens Ring in 1960 jointly with Otto Bayer and Walter Reppe, for expanding the scientific knowledge of and the technical development of new synthetic materials.

Karl Ziegler

(26 Nov. 1898 - 12 Aug. 1973)

Early Life and Education

- Karl Ziegler was born in Helsa near Kassel in Germany. An introductory physics textbook first sparked Ziegler's interest in science. It drove him to perform experiments in his home and to read extensively beyond his high school curriculum. He was also introduced to many notable individuals through his father, including Emil Adolf von Behring, recognized for the Diphtheria vaccine. His extra study and experimentation helped to explain why he received an award for the most outstanding student in his final year at high school in Kassel, Germany. He studied at the University of Marburg. However his studies were interrupted, as during 1918 he was deployed to the front as a soldier to serve in World War I. He received his Ph.D. in 1920, on "Studies on semibenzole and related links".

Research and Contributions

- In 1926, he became a professor at the University of Heidelberg where he investigated the stability of radicals on trivalent carbons leading him to study organometallic compounds and their application in his research. He also worked on the syntheses of multi-membered ring systems. In 1933, Ziegler published his first major work on large ring systems, "Vielgliedrige Ringsysteme" which presented the fundamentals for the Ruggli-Ziegler dilution principle.
- Karl Ziegler was credited with much of the postwar resurrection of chemical research in Germany and helped found the German Chemical Society where he served as a president for five years. He was also the president of the German Society for Petroleum Science and Coal Chemistry, from 1954 to 1957. In 1971, The Royal Society, London, elected him as a Foreign Member.

Known For

- Ziegler-Natta catalyst
- Ziegler process
- Wohl-Ziegler bromination
- Thorpe-Ziegler reaction
- Organoaluminium chemistry
- Organolithium reagent

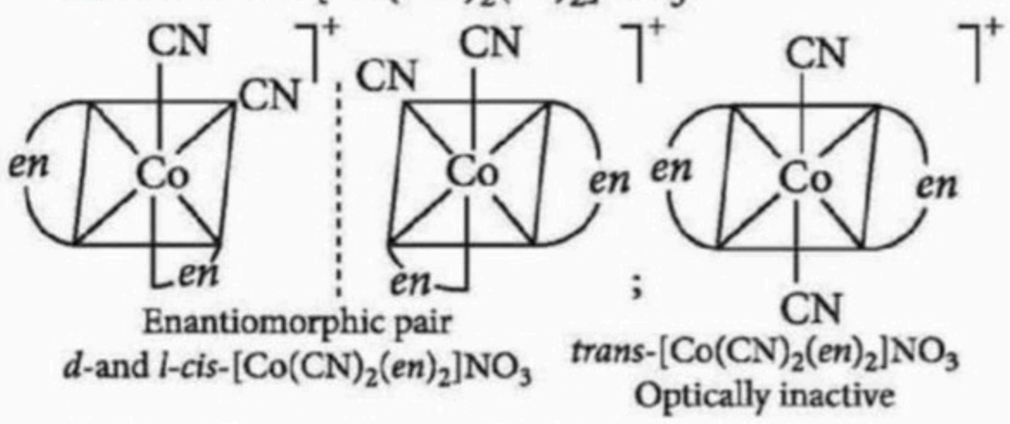
Awards

- Liebig Medal (1935)
- War Merit Cross 2nd Class (1940)
- Werner von Siemens Ring (1961)
- Nobel Prize for Chemistry (1963)

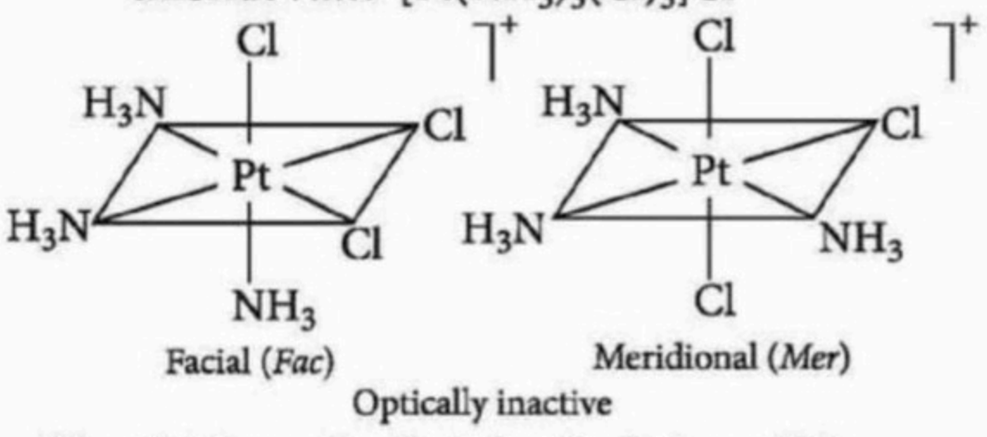
CHEMISTRY MUSING

SOLUTION SET 80

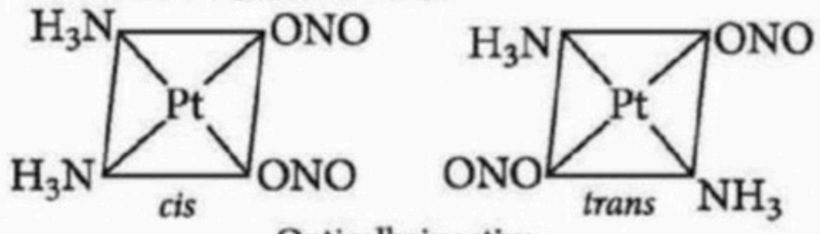
1. (a) : (a) *trans*-Dicyano*bis*(ethylenediamine)cobalt(III) nitrate : *trans*-$[Co(CN)_2(en)_2]NO_3$



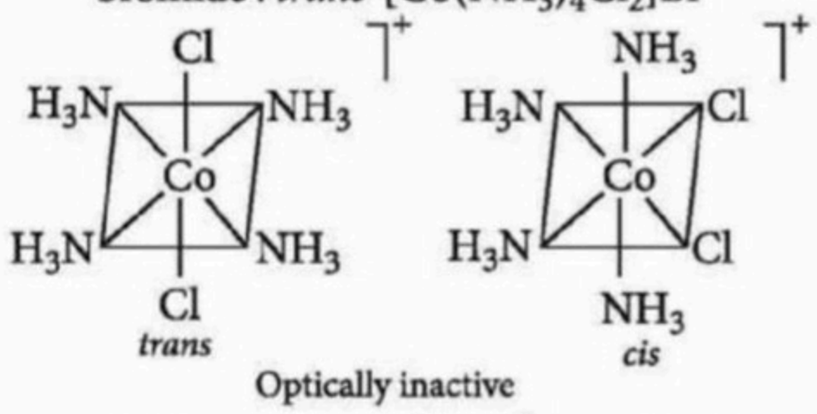
(b) *mer*-Triamminetrichloridoplatinum(IV) chloride : *mer*-$[Pt(NH_3)_3(Cl)_3]Cl$



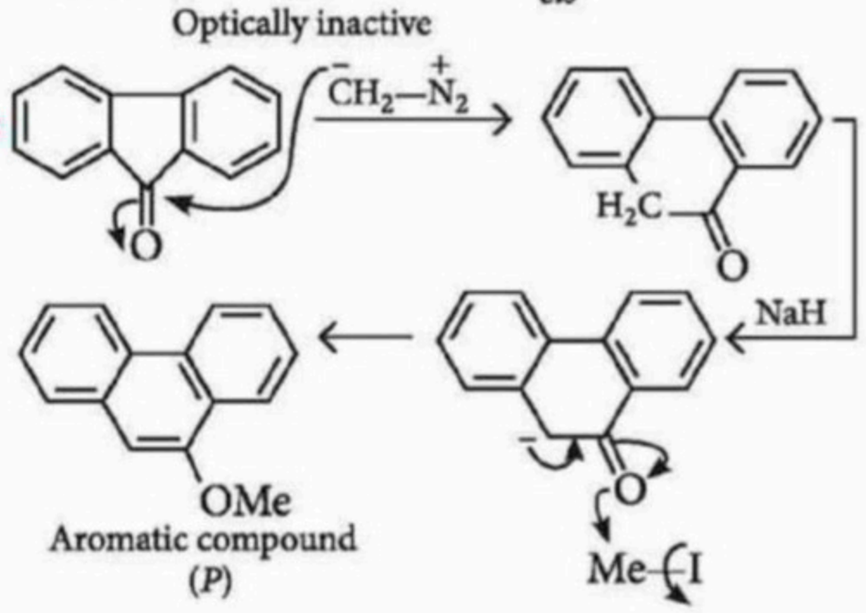
(c) *cis*-Diamminedinitrito-O-platinum(II) : *cis*-$[Pt(NH_3)_2(ONO)_2]$



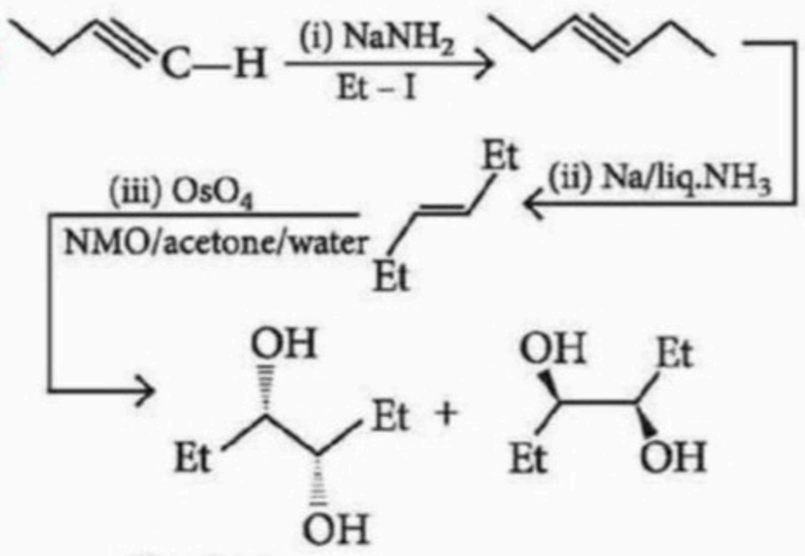
(d) *trans*-Tetraamminedichloridocobalt(III) bromide : *trans*-$[Co(NH_3)_4Cl_2]Br$



2. (b) :



3. (c) :



4. (b) : $ZnS \xrightarrow{\text{Roasting}} ZnO + SO_2$

$ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$ (dil.)

$ZnSO_4 \xrightarrow[\text{basic medium}]{H_2S \text{ in}} ZnS + H_2SO_4$

5. (c) : Let NaCl and $CaCl_2$ be a, b g respectively in 1 g of a mixture.

$\therefore \quad a + b = 1$

Also, Meq. of $CaCl_2$ = Meq. of CaC_2O_4 = Meq. of $KMnO_4 = 22 \times 0.1 \times 5 = 11$

$\therefore$ Weight of $CaCl_2 = 11 \times \frac{111}{2} \times \frac{1}{1000} = 0.61$ g

Weight of NaCl = 0.39 g

$\therefore$ Weight of $CaCl_2$ in 5 g mixture $= 0.61 \times 5 = 3.05$ g

Weight of NaCl in 5 g mixture $= 0.39 \times 5 = 1.95$ g

$$\text{Now, } \Delta T = \frac{1000\,K_b}{W}\left[\underset{\text{for NaCl}}{(1+\alpha)\frac{w}{m}} + \underset{\text{for } CaCl_2}{(1+2\alpha)\frac{w}{m}}\right]$$

$$= \frac{1000 \times 1.86}{100}\left[(1+1) \times \frac{1.95}{58.5} + (1+2) \times \frac{3.05}{111}\right]$$

$$= \frac{1000 \times 1.86}{100} \times 0.149 = 2.77 \text{ K}$$

$\therefore$ Freezing point = 273 – 2.77 = 270.23 K

COMIC CAPSULE

DON'T DRINK WATER WHILE STUDYING.
BECAUSE CHEMISTRY SAYS THAT

CONCENTRATION DECREASES ON ADDING WATER

6. (a, b): (a) $Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$

(b) $2MnO_4^- + 16H^+ + 10I^- \longrightarrow 2Mn^{2+} + 5I_2 + 8H_2O$

$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$

7. (b): Heat transferred to the calorimeter = Heat capacity of the calorimeter × Rise in temperature

$= 17.7 \text{ kJ K}^{-1} \times (0.5 \text{ K}) = 8.85 \text{ kJ}$

Molar mass of $CH_4 = 12 + 4 = 16 \text{ g mol}^{-1}$

Enthalpy of combustion of CH_4 at constant volume *i.e.*,

$$\Delta E = -\left(\frac{8.85}{0.16} \times 16\right) = -885 \text{ kJ mol}^{-1}$$

8. (a): $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$

$\Delta H = \Delta E + \Delta n_g RT$

$= -885 + (-2 \times 8.314 \times 10^{-3} \times 300)$

$= -885 - 4.988 \text{ kJ mol}^{-1} = -889.988 \text{ kJ mol}^{-1}$

9. (8):

C	H	N
9	1	3.5
$\frac{9}{12}$	$\frac{1}{1}$	$\frac{3.5}{14}$
$\frac{3}{4}$	$\frac{1}{1}$	$\frac{1}{4}$
3	4	1

Empirical formula = C_3H_4N

$(C_3H_4N)_n = 108$

$(12 \times 3 + 1 \times 4 + 14)_n = 108$

$54n = 108 \Rightarrow n = 108/54 = 2$

Molecular formula = $C_6H_8N_2$

No. of H-atom in $C_6H_8N_2 = 8$

10. (3): 0.4 M of $A \xrightarrow{30 \text{ min.}} 0.2 \text{ M} \xrightarrow{30 \text{ min.}} 0.1 \text{ M}$ (for A)

Temperature coefficient = $2 = \frac{k(\text{at } 35°C)}{k(\text{at } 25°C)}$

$\Rightarrow \quad 2k \text{ (at } 25°C) = k \text{ (at } 35°C)$

Now, for second order reaction rate constant (k) is inversely proportional to half-life ($t_{1/2}$).

As, k at 35°C gets doubled so, $t_{1/2}$ will be halved.

0.4 M of $B \xrightarrow{20 \text{ min.}} 0.2 \text{ M} \xrightarrow{20 \text{ min.}} 0.1 \text{ M} \xrightarrow{20 \text{ min.}}$ 0.05 M (for B)

$\therefore \quad \frac{[A]}{[B]} = \frac{0.1}{0.05} = 2:1$

Sum of ratio = 2 + 1 = 3

10 MIND BLOWING PROBLEMS

OLYMPIAD CORNER

OBJECTIVE PROBLEMS

1. The magnetic moment of a certain complex (*A*) of Co was found to be 4.89 B.M. and the EAN is 36. Co also forms complex (*B*) with magnetic moment 3.87 B.M. and EAN is 37 and complex (*C*) with EAN, 36 but diamagnetic. Which of the following statements is true regarding the above observation?

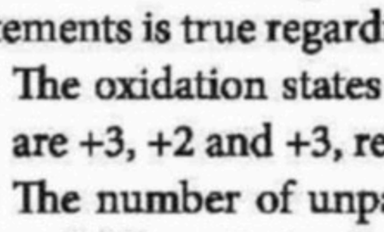
(a) The oxidation states of Co in (*A*), (*B*) and (*C*) are +3, +2 and +3, respectively.

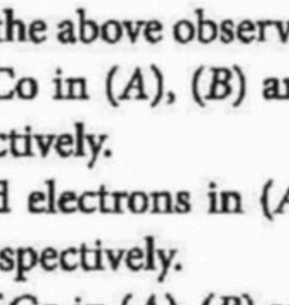
(b) The number of unpaired electrons in (*A*), (*B*) and (*C*) are 3, 4 and 0, respectively.

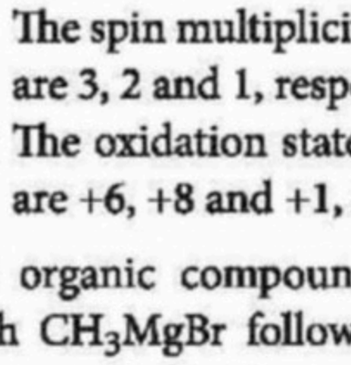
(c) The spin multiplicities of Co in (*A*), (*B*) and (*C*) are 3, 2 and 1, respectively.

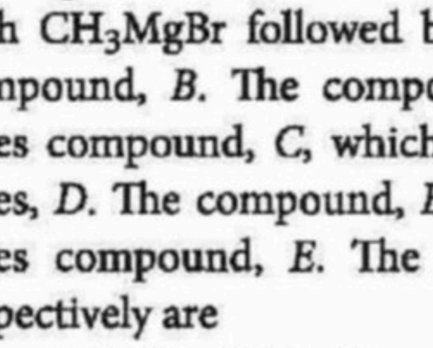
(d) The oxidation states of Co in (*A*), (*B*) and (*C*) are +6, +8 and +1, respectively.

2. An organic compound *A*, $C_6H_{10}O$ on reaction with CH_3MgBr followed by acid treatment gives compound, *B*. The compound, *B* on ozonolysis gives compound, *C*, which in presence of a base gives, *D*. The compound, *B* on reaction with HBr gives compound, *E*. The compounds *D* and *E* respectively are

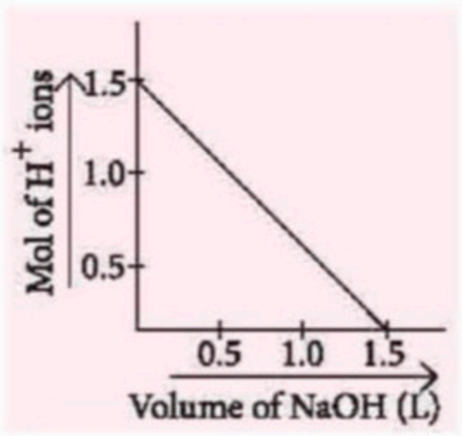
(a) 

(b) 

(c) 

(d) 

3. To 1 L of 1.0 M impure H_2SO_4 sample, 1.0 M NaOH solution was added and a plot was obtained as follows :

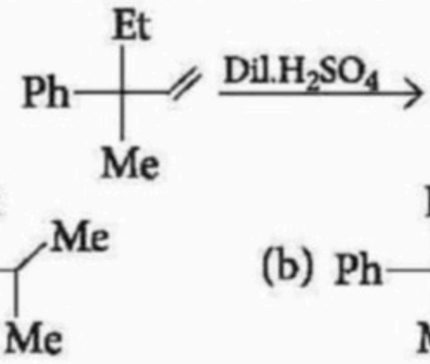


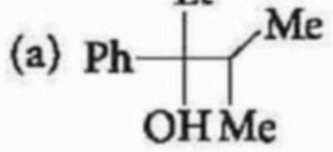
The % purity of H_2SO_4 and the slope of curve, respectively, are

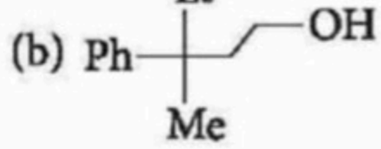
(a) 75%, – 1/2 (b) 75%, – 1

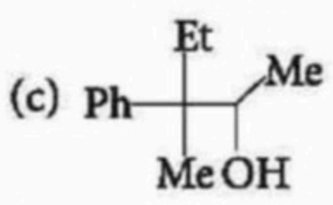
(c) 50%, – 1/3 (d) 50%, – 1/4

4. The major product in the reaction is



(a) 

(b) 

(c) 

(d) both (b) and (c).

5. A quantity of air ($\gamma = 1.4$) at 300 K is compressed slowly in case I and suddenly to half of its volume in case II. Which of the following is correct regarding the change in temperature in both cases?

(a) Case I, $\Delta T = 0$ K, case II, $\Delta T = 395.36$ K

(b) Case I, $\Delta T = 395.36$ K, case II, $\Delta T = 95.36$ K

(c) Case I, $\Delta T = 10$ K, case II, $\Delta T = 368.36$ K

(d) Case I, $\Delta T = 0$ K, case II, $\Delta T = 95.36$ K

SUBJECTIVE PROBLEMS

6. What will be the angular frequency of an electron occupying the second Bohr's orbit of He^+ ion?

7. An aromatic compound contains 69.4% carbon and 5.8% hydrogen. A sample of 0.303 g of this compound was analysed for nitrogen by Kjeldahl's method. The ammonia evolved was absorbed in

50 mL of 0.05 M sulphuric acid. The excess of acid required 25 mL of 0.1 M sodium hydroxide for neutralisation. Determine the molecular formula of the compound if its molecular weight is 121. Draw two possible structures for this compound.

8. A mixture contains NaCl and an unknown chloride *M*Cl. (i) 1 g of this is dissolved in water. Excess of acidified $AgNO_3$ solution is added to it. 2.567 g of a white precipitate is formed. (ii) 1 g of the original mixture is heated to 300°C. Some vapours come out which are absorbed in acidified $AgNO_3$ solution. 1.341 g of a white precipitate is obtained. Find the molecular weight of the unknown chloride.

9. How many moles of sodium propionate should be added to one litre of an aqueous solution containing 0.020 mole of propionic acid to obtain a buffer solution of pH 4.75? What will be pH if 0.010 mole of hydrogen chloride is dissolved in the above buffer solution. (Dissociation constant of propionic acid, K_a at 25°C = 1.34×10^{-5})

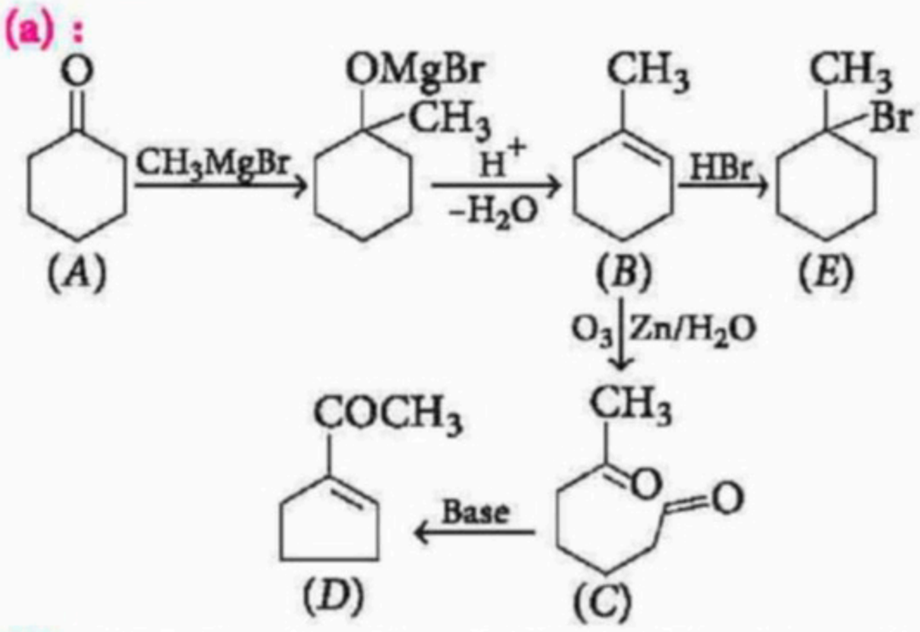
10. A flask of 1L having $NH_{3(g)}$ at 2.0 atm and 200 K is connected with another flask of volume 800 mL having $HCl_{(g)}$ at 8 atm and 200 K through a narrow tube of negligible volume. The two gases react to form $NH_4Cl_{(s)}$ with evolution of 43 kJ mol^{-1} of heat. If heat capacity of $HCl_{(g)}$ at constant volume is 20 J K^{-1} mol^{-1} and neglecting heat capacity of flask, NH_4Cl and volume of solid NH_4Cl formed, calculate final temperature in flask.
(R = 0.08 L-atm K^{-1} mol^{-1})

SOLUTIONS

1. (a) :

Complex	Magnetic moment	No. of unpaired electrons	Electronic configuration	Oxidation state
(*A*)	4.89 B.M.	4	$Co \rightarrow 3d^6$; ⇅ 1 1 1 1	+3
(*B*)	3.87 B.M.	3	$Co \rightarrow 3d^7$; ⇅ ⇅ 1 1 1	+2
(*C*)	0 B.M.	0	$Co \rightarrow 3d^6$; ⇅ ⇅ ⇅	+3

2. (a) :



3. (b) : I. Moles of NaOH = 1.0 M × 1.5 L = 1.5 mol

Moles of H_2SO_4 = 1.0 M × 1L = 1.0 mol

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$
2 mol 1 mol

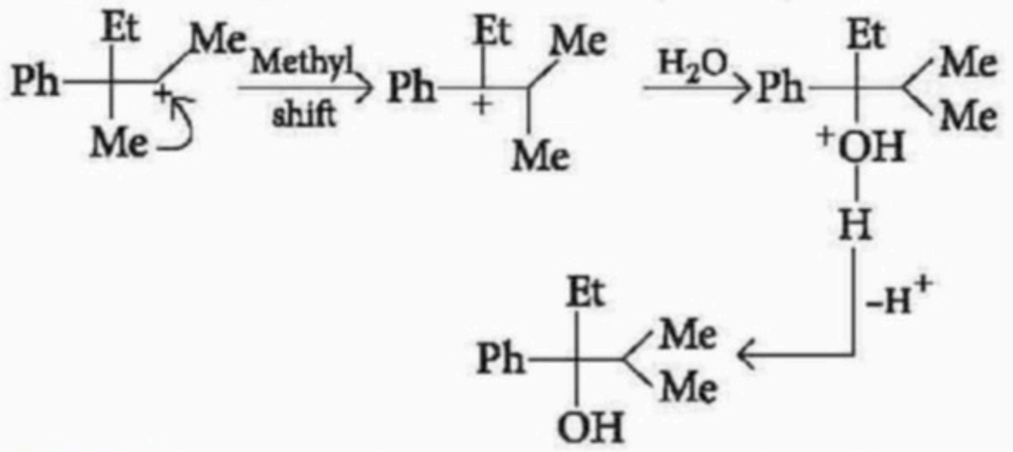
Moles of H_2SO_4 reacted with NaOH

$$= \frac{1}{2} \times 1.5 = 0.75 \text{ mol } H_2SO_4$$

$$\% \text{ purity of } H_2SO_4 = \frac{0.75 \text{ mol} \times 100}{1.0 \text{ mol}} = 75\%$$

II. For slope : $\frac{x}{a} + \frac{y}{b} = 1$; Slope $= \frac{-b}{a} = \frac{-1.5}{1.5} = -1$

4. (a) : The product is obtained by methyl shift.



5. (d) : For case I, heat produced can be exchanged with surroundings due to slow process and hence, the change is isothermal, *i.e.*, $\Delta T = 0$.

For case II, the change is adiabatic.

Thus, $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$$300 \times V^{(1.4-1)} = T_2 \times \left(\frac{V}{2}\right)^{(1.4-1)}$$

$300 \times (2)^{(0.4)} = T_2$; $\log 300 + 0.4 \log 2 = \log T_2$

$2.477 + 0.120 = \log T_2$; $2.597 = \log T_2$

T_2 = Antilog (2.597) = 395.36 K

Change in temperature (ΔT) = $T_2 - T_1$ = 95.36 K

6. Velocity of electron in He^+ ion in an orbit $(v) = \frac{2\pi Ze^2}{nh}$

Radius of He^+ ion in an orbit $(r_n) = \frac{n^2h^2}{4\pi^2me^2Z}$

$\therefore$ Angular frequency,

$$\omega = \frac{v}{r_n} = \frac{2\pi Ze^2 \times 4\pi^2me^2Z}{nh \times n^2h^2} = \frac{8\pi^3Z^2me^4}{n^3h^3}$$

$\because$ $n = 2$, $m = 9.108 \times 10^{-28}$ g, $Z = 2$,
$h = 6.625 \times 10^{-27}$ erg sec
$e = 4.803 \times 10^{-10}$ esu

$$\omega = \frac{8 \times (22/7)^3 \times (2)^2 \times 9.108 \times 10^{-28} \times (4.803 \times 10^{-10})^4}{(2)^3 \times (6.625 \times 10^{-27})^3}$$

$$= 2.06 \times 10^{16} \text{ sec}^{-1}$$

7. To calculate percentage of nitrogen :

50 mL of 0.05 M H_2SO_4 = 50 mL of 0.1 N H_2SO_4 [$\because N = 2 \times M$]

Excess of acid required 25 mL of 0.1 M or 0.1 N NaOH [$\because N = M$]

25 mL of 0.1 N NaOH = 25 mL of 0.1 N H_2SO_4 [$N_1V_1 = N_2V_2$]

$\therefore$ Volume of 0.1 N H_2SO_4 used for neutralisation of NH_3 = 50 – 25 = 25 mL

Hence, % age of N

$$= \frac{1.4 \times \text{normality of acid} \times \text{volume of acid}}{\text{weight of the compound}}$$

$$\text{Percentage of nitrogen} = \frac{1.4 \times 0.1 \times 25}{0.303} = 11.55\,\%$$

Percentage of oxygen = 100 – (69.4 + 5.8 + 11.55) = 13.25%

Empirical formula :

Element	%	Relative number	Simplest ratio of atoms
C	69.4	69.4/12 = 5.8	5.8/0.825 = 7
H	5.8	5.8/1 = 5.8	5.8/0.825 = 7
N	11.55	11.55/14 = 0.825	0.825/0.825 = 1
O	13.25	13.25/16 = 0.828	0.825/0.828 = 1

Hence, empirical formula of the aromatic compound = C_7H_7NO

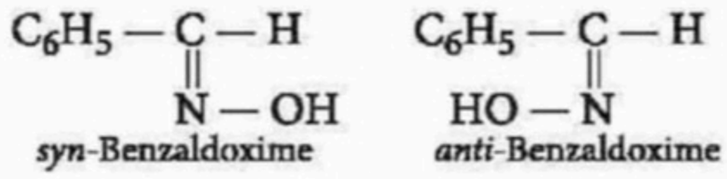
Empirical formula weight
= 7 × 12 + 7 × 1 + 1 × 14 + 1 × 16 = 84 + 7 + 14 + 16 = 121

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{121}{121} = 1$$

Hence, molecular formula = C_7H_7NO.

Structure of the compound :

Since the compound is aromatic, we can write its formula as $C_6H_5CH_2NO$ or $C_6H_5CH{=}NOH$ (benzaldoxime). It can exist in following two isomeric structures :



8. Total weight of AgCl obtained = 2.567 g

NaCl does not decompose on heating to 300°C. Therefore, amount of AgCl formed due to MCl = 1.341 g

$\therefore$ Weight of AgCl formed due to NaCl
= 2.567 – 1.341 g = 1.226 g

NaCl $\equiv$ AgCl $\equiv$ MCl
23 + 35.5 = 58.5 ; 108 + 35.5 = 143.5

143.5 g of AgCl is obtained from NaCl = 58.5 g

$\therefore$ 1.226 g of AgCl is obtained from NaCl

$$= \frac{58.5}{143.5} \times 1.226\text{ g} = 0.4998\text{ g}$$

$\therefore$ Weight of MCl in 1 g of mixture = 1.000 – 0.4948 g
= 0.5002 g

1.341 g AgCl is obtained from MCl = 0.5052 g

143.5 g AgCl is obtained from $MCl = \frac{0.5002}{1.341} \times 143.5$ g
= 53.53

Hence, molecular weight of MCl = 53.53 g.

9. Let the number of moles of sodium propionate = x

$$\therefore \quad pH = pK_a + \log\frac{[\text{Salt}]}{[\text{Acid}]} = -\log(1.34 \times 10^{-5}) + \log\left[\frac{x}{0.02}\right]$$

$$\text{or} \quad 4.75 = -\log(1.34 \times 10^{-5}) + \log\left[\frac{x}{0.02}\right]$$

$$\text{or} \quad 4.75 = 4.8729 + \log\left[\frac{x}{0.02}\right]$$

$$\text{or} \quad \log\frac{x}{0.02} = 4.75 - 4.8729 = -0.1229$$

or $x = 1.5 \times 10^{-2}$ moles

$\therefore$ Amount of sodium propionate = 1.5×10^{-2} moles

When 0.01 moles of HCl is added, 0.03 moles (0.01 + 0.02) propionic acid and 0.005 moles (0.015 – 0.010) of sodium propionate are formed.

$$\therefore \quad pH = -\log(1.34 \times 10^{-5}) + \log\frac{0.005}{0.03}$$

$$= 4.87 - 0.78 = 4.09$$

10. $NH_{3(g)} + HCl_{(g)} \longrightarrow NH_4Cl_{(s)}$; $\Delta H = -43.0$ kJ

Initial mole	$\frac{2\times1}{0.08\times200}$	$\frac{8\times0.8}{0.08\times200}$	
	0.125	0.4	0
Final mole	0	0.275	0.125

$\therefore$ Heat produced = 0.125 × 43 = 5.375 kJ

The heat produced is used to increase the temperature of HCl left in flask since heat capacity of flask and NH_4Cl = 0

$\therefore$ $Q = n \times C_v \times \Delta T$

$5.375 \times 10^3 = 0.275 \times 20 \times \Delta T \Rightarrow \Delta T = 977.27$ K

$\therefore$ Final temperature = 200 + 977.27 = 1177.27 K

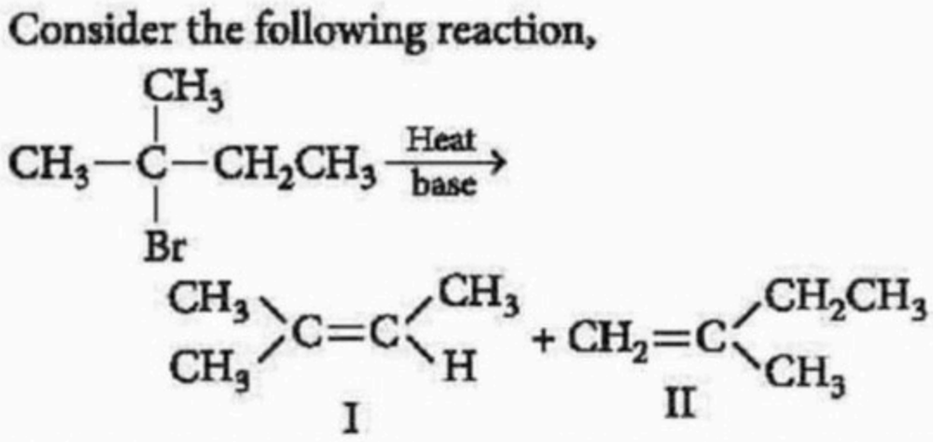
GET SET GO for NEET

Exam on May 3, 2020

with exclusive and brain storming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

1. Consider the following reaction,



Which of the following base will give the best yield of the alkene II as the major product?

(a) CH_3O^- (b) $C_2H_5O^-$

(c) $(CH_3)_3CO^-$ (d) $(C_2H_5)_3CO^-$

2. If 10^{21} molecules are removed from 200 mg of CO_2, then the number of moles of CO_2 left are

(a) 2.87×10^{-3} (b) 28.8×10^{-3}

(c) 0.288×10^{-3} (d) 1.68×10^{-2}

3. On addition of increasing amount of $AgNO_3$ to 0.1 M each of NaCl and NaBr in a solution, what % of Br^- ion get precipitated when Cl^- ion starts precipitating?

[$K_{sp}(AgCl) = 1.0 \times 10^{-10}$, $K_{sp}(AgBr) = 1 \times 10^{-13}$]

(a) 0.11 (b) 99.9

(c) 0.01 (d) 9.99

4. In a measurement of quantum efficiency of photosynthesis in green plants, it was found that 10 quanta of red light of wavelength 6850 Å were needed to release one molecule of O_2. The average energy storage in this process for 1 mole O_2 evolved is 112 kcal. What is the energy conversion efficiency in this experiment?

(Given : 1 cal = 4.18 J; $N_A = 6 \times 10^{23}$, $h = 6.63 \times 10^{-34}\ m^2\ kg\ s^{-1}$)

(a) 23.5 (b) 26.9 (c) 66.37 (d) 73.1

5. Which of the following statements about polar stratospheric clouds (PSCs) is not correct?

(a) PSCs are formed over Antarctica during summer season.

(b) Type I clouds are formed at about –77°C and contain solid $HNO_3 \cdot 3H_2O$.

(c) Type II clouds are formed at about – 85°C and contain some ice.

(d) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica.

6. The C—C single bond length is 1.54 Å and that of Cl—Cl is 1.98 Å. If the electronegativity of Cl and C are 3.0 and 2.5 respectively, the C—Cl bond length will be equal to

(a) 3.12 Å (b) 1.67 Å (c) 1.71 Å (d) 2.12 Å

7. ΔH_f° of NF_3 is -113 kJ mol^{-1} and N—F bond energy is 273.0 kJ mol^{-1}. If N ≡ N and F—F bond energies are in the ratio of 6 : 1 then their magnitudes will be respectively

(a) 780.0 kJ mol^{-1} and 130.0 kJ mol^{-1}
(b) 840.0 kJ mol^{-1} and 140.0 kJ mol^{-1}
(c) 950.0 kJ mol^{-1} and 158.3 kJ mol^{-1}
(d) 941.3 kJ mol^{-1} and 156.9 kJ mol^{-1}.

8. *n*-factors for Cu_2S and CuS when they react with $KMnO_4$ in acidic medium are (neglecting the further oxidation of released SO_2.)

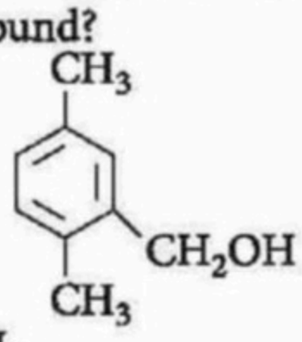
(a) 7, 7 (b) 6, 6 (c) 6, 8 (d) 8, 6

9. Let the most probable velocity of hydrogen molecules at a temperature of t°C be V_0. When the temperature is raised to $(2t + 273)$°C the new *rms* velocity is (suppose all the molecules dissociate into atoms at later temperature.)

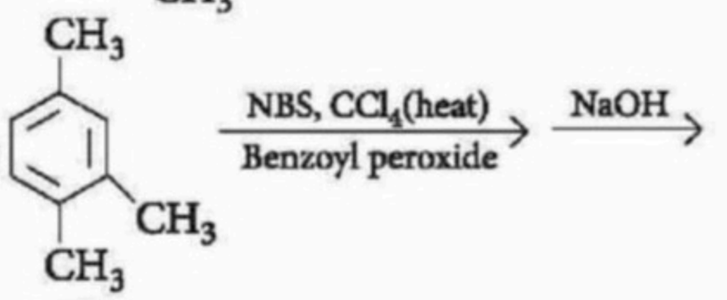
(a) $2\sqrt{3}\,V_0$ (b) $\sqrt{6}\,V_0$

(c) $\sqrt{3\left(2+\frac{273}{t}\right)V_0}$ (d) $\sqrt{\frac{2}{3}V_0}$

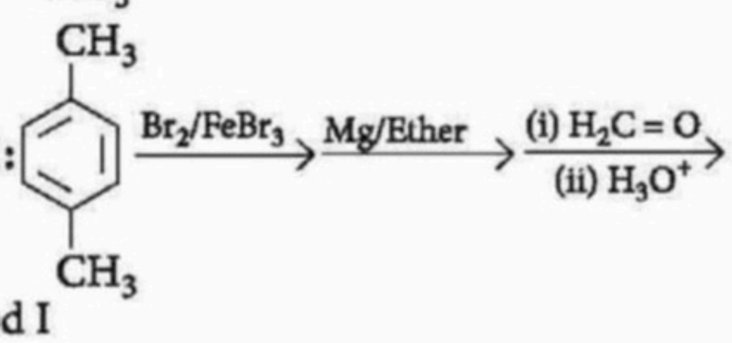
10. Which method is best for the synthesis of the following compound?



Method I :



Method II :



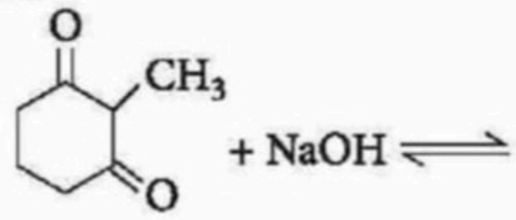
(a) Method I
(b) Method II
(c) Both methods (I) and (II) are equally good.
(d) Neither method (I) nor method (II).

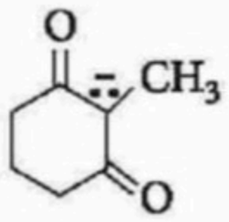
11. Which one of the following statement is wrong for the following reaction sequence?

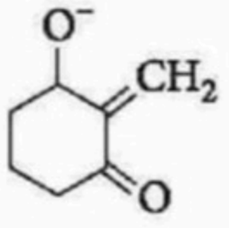
$$[A] + NaCr(OH)_4 \xrightarrow[\text{Boil}]{H_2O_2} \underset{\text{Yellow colour sol.}}{(B)} \xrightarrow{H_2SO_4} \underset{\text{Orange colour comp.}}{(C)}$$

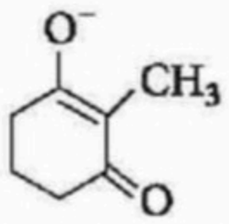
(a) [*A*] is NaOH. (b) [*B*] is Na_2CrO_3.
(c) [*B*] is Na_2CrO_4. (d) [*C*] is $Na_2Cr_2O_7$.

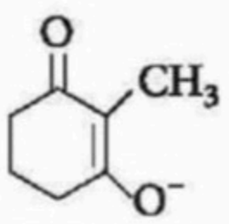
12. Which of the following is not a resonance form of the enolate ion formed in the following acid-base equilibrium?



(a) 

(b) 

(c) 

(d) 

13. Which of the following is not correct from the viewpoint of molecular orbital?

(a) Be_2 is not a stable molecule.
(b) He_2 is not stable but He^+ is expected to exist.
(c) Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules.
(d) The order of energies of molecular orbitals in F_2 molecule is $KK\sigma 2s^2 < \sigma^* 2s^2 < \pi 2p_x^2 = \pi 2p_y^2 < \sigma 2p_z^2 < \pi^* 2p_x^2 = \pi^* 2p_y^2$

14. A mixture of Na_2CO_3 and K_2CO_3 is used as fusion mixture because

(a) it has lower m.pt than Na_2CO_3 and converts metal salts to carbonates which decompose to metal oxides
(b) it has higher m.pt than K_2CO_3 and converts metal salts to carbonates, which decompose to metal oxides
(c) it has lower m.pt. than both Na_2CO_3 and K_2CO_3 and converts the metal salts to carbonates, which decompose to metal oxides
(d) it has higher m.pt. than both Na_2CO_3 and K_2CO_3 and converts the metal salts to carbonates which decompose to metal oxide.

15. In the following reaction, $B_2H_6 + NH_3 \xrightarrow{120°C} X$, *X* is

(a) $[BH_2(NH_3)_2]^+[BH_4]^-$
(b) $[BH_2(NH_3)_2]^+[BH_3]^-$
(c) $(BH_4)^+\,[BH_2(NH_3)_2]^-$
(d) $(BH_3)^+\,[BH_3(NH_3)_2]^-$

SOLUTIONS

1. (d) : Alkene II is less substituted means Hofmann's product. Bulky base gives Hofmann's product.

2. (a) : 200 mg of $CO_2 = 200 \times 10^{-3} = 0.2$ g

44 g of $CO_2 = 6.023 \times 10^{23}$ molecules

$$0.2 \text{ g of } CO_2 = \frac{6.023 \times 10^{23}}{44} \times 0.2 = 0.0273 \times 10^{23}$$
$$= 2.73 \times 10^{21} \text{ molecules}$$

Now, as 10^{21} molecules are removed, so remaining molecules $= 2.73 \times 10^{21} - 10^{21}$
$= 10^{21}(2.73 - 1) = 1.73 \times 10^{21}$ molecules

Now, 6.023×10^{23} molecules = 1 mole

$$\therefore 1.73 \times 10^{21} \text{ molecules} = \frac{1 \times 1.73 \times 10^{21}}{6.023 \times 10^{23}} = 0.287 \times 10^{-2}$$
$$= 2.87 \times 10^{-3} \text{ moles}$$

3. (b) : To precipitate the AgCl,

$$[Ag^+] \text{ required} = \frac{K_{sp}(AgCl)}{[Cl^-]} = \frac{1.0 \times 10^{-10}}{0.1} = 1.0 \times 10^{-9} \text{ M}$$

$$[Br^-] \text{ left at this stage} = \frac{K_{sp}(AgBr)}{[Ag^+]} = \frac{1.0 \times 10^{-13}}{1.0 \times 10^{-9}}$$
$$= 1.0 \times 10^{-4} \text{ M}$$

$$\% \text{ of remaining } [Br^-] = \frac{1.0 \times 10^{-4}}{0.1} \times 100 = 0.1$$

% of $[Br^-]$ to be precipitated = 100 – 0.1 = 99.9

4. (b) : $E = \frac{hc}{\lambda} = 2.9 \times 10^{-19}$ J

Total energy of 10 quanta $= 10 \times 2.9 \times 10^{-19} = 29 \times 10^{-19}$ J

$$\text{Energy stored for process} = \frac{112 \times 4.18 \times 10^3}{6 \times 10^{23}}$$
$$= 7.80 \times 10^{-19} \text{ J}$$

$$\% \text{ efficiency} = \frac{7.80 \times 10^{-19}}{29 \times 10^{-19}} \times 100 = 26.9$$

5. (a)

6. (c) : For a diatomic hetero molecule,

$d_{A-B} = r_A + r_B - 0.09(\chi_A - \chi_B)$

Where, χ_A = Electronegativity of more electronegative atom

χ_B = Electronegativity of less electronegative atom

Thus, $r_C = \frac{1.54}{2} = 0.77$ Å, $r_{Cl} = \frac{1.98}{2} = 0.99$ Å

$\chi_{Cl} - \chi_C = 3.0 - 2.5 = 0.5$

$d_{C-Cl} = 0.77 + 0.99 - 0.09 \times 0.5 = 1.71$ Å

7. (d) : $\frac{1}{2}N_{2(g)} + \frac{3}{2}F_{2(g)} \longrightarrow NF_3$; $\Delta H = -113$ kJ

or $\frac{1}{2}\Delta H_{N \equiv N} + \frac{3}{2}\Delta H_{F-F} - 3\Delta H_{N-F} = -113$ kJ

Let x kJ mol^{-1} be the bond energy of F—F bond then bond energy of N ≡ N bond will be $6x$.

$$\therefore \quad \frac{1}{2} \times 6x + \frac{3}{2} \times x - 3 \times 273 = -113 \text{ kJ}$$

On solving, $x = 156.9$ kJ mol^{-1}

Therefore, N≡N bond energy $= 6 \times 156.9$
$= 941.3$ kJ mol^{-1}

and F—F bond energy = 156.9 kJ mol^{-1}

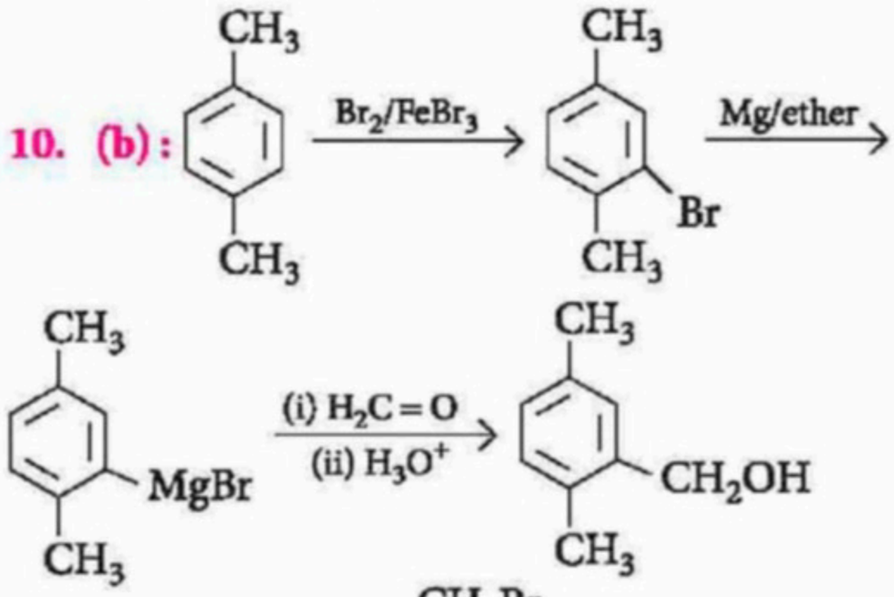
8. (d) : $\left.\begin{array}{l} Cu_2^{2+} \rightarrow 2Cu^{2+} + 2e^- \ (n = 2) \\ S^{2-} \rightarrow SO_2 + 6e^- \ (n = 6) \end{array}\right] (n = 8)$

Cu^{2+} does not change only S^{2-} changes to SO_2 hence, $n = 6$

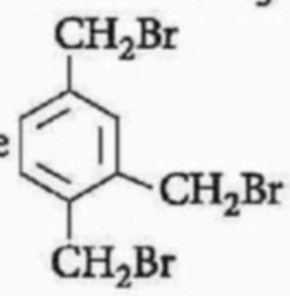
9. (b) : $V_0 = \sqrt{\frac{2RT}{M}} = \sqrt{R(273 + t)}$

$$V_{rms} = \sqrt{\frac{3(2t + 273 + 273)R}{1}} = \sqrt{6(t + 273)R} = \sqrt{6}V_0$$

10. (b) :



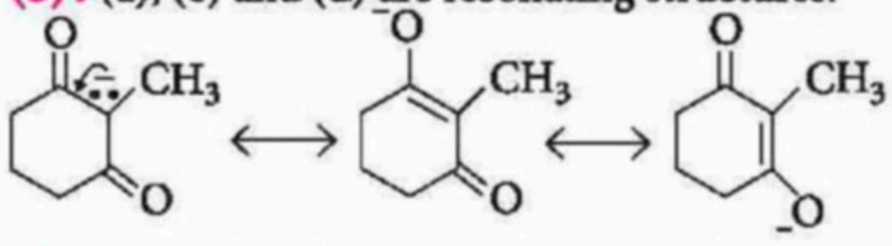
Method (I) will give



11. (b) : $2NaCr(OH)_4 + 2NaOH + 3H_2O_2 \xrightarrow{\text{Boil}}$ (A)

$8H_2O + 2Na_2CrO_4 \xrightarrow{H_2SO_4} Na_2Cr_2O_7$ (B) (C)

12. (b) : (a), (c) and (d) are resonating structures.



13. (d) : The molecular orbital electronic configuration of F_2 molecule is $\sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < \sigma 2p_z^2 < \pi 2p_x^2 = \pi 2p_y^2 < \pi^* 2p_x^2 = \pi^* 2p_y^2$

14. (c)

15. (a) : $B_2H_6 + 2NH_3 \xrightarrow{120°C} [BH_2(NH_3)_2]^+ [BH_4]^-$

MONTHLY TEST DRIVE

This specially designed column enables students to self analyse their extent of understanding of all chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

PRACTICE PAPER

Total Marks : 120 **Time Taken : 60 Min.**

NEET

Only One Option Correct Type

1. If H-atom is supplied with 12.1 eV energy and electron returns to the ground state after excitation then number of spectral lines in Balmer series would be
(Use energy of ground state of H-atom = –13.6 eV)
(a) 1 (b) 2 (c) 3 (d) 4

2. n_1 and n_2 moles of two ideal gases having molecular weights M_1 and M_2 respectively at temperatures T_1 K and T_2 K are mixed. Assuming no loss of energy, the temperature of mixture will become

(a) $n_1T_1 + n_2T_2$ (b) $\frac{n_1T_1 + n_2T_2}{T_1 + T_2}$

(c) $\frac{n_1T_1 + n_2T_2}{n_1 + n_2}$ (d) $\frac{T_1 \times T_2}{n_1 \times n_2}$

3. The formation of the oxide ion, $O^{2-}_{(g)}$, from oxygen atom requires first an exothermic and then an endothermic step as shown below :

$O_{(g)} + e^- \longrightarrow O^-_{(g)}$; $\Delta H^\circ = -141$ kJ mol^{-1}

$O^-_{(g)} + e^- \longrightarrow O^{2-}_{(g)}$; $\Delta H^\circ = +780$ kJ mol^{-1}

Thus, process of formation of O^{2-} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that
(a) oxygen is more electronegative
(b) addition of electron in oxygen results in larger size of the ion
(c) electron repulsion outweighs the stability gained by achieving noble gas configuration
(d) O^- ion has comparatively smaller size than oxygen atom.

4. Ethanol can undergoes decomposition to form two sets of products.

$$C_2H_5OH_{(g)} \xrightarrow{1} C_2H_{4(g)} + H_2O_{(g)};\ \Delta H^\circ = 45.54 \text{ kJ}$$

$$C_2H_5OH_{(g)} \xrightarrow{2} CH_3CHO_{(g)} + H_{2(g)};\ \Delta H^\circ = 68.91 \text{ kJ}$$

If the molar ratio of C_2H_4 to CH_3CHO is 8 : 1 in a set of product gases, then the energy involved in the decomposition of 1 mole of ethanol is
(a) 114.45 kJ (b) 48.137 kJ
(c) 23.37 kJ (d) 57.22 kJ

5. When $KMnO_4$ acts as an oxidising agent and ultimately forms $[MnO_4]^{2-}$, MnO_2, Mn_2O_3, Mn^{2+} then the number of electrons transferred in each case respectively is
(a) 4, 3, 1, 5 (b) 1, 5, 3, 7
(c) 1, 3, 4, 5 (d) 3, 5, 7, 1

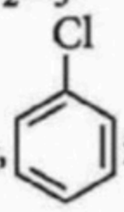
6. When cyclohexane is poured on water, it floats, because
(a) cyclohexane is in 'boat' form
(b) cyclohexane is in 'chair' form
(c) cyclohexane is in 'crown' form
(d) cyclohexane is less denser than water.

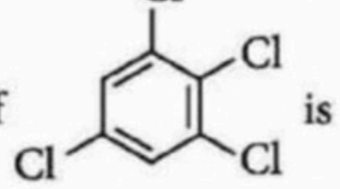
7. *X* and *Y* are metal nitrates. *X* on heating liberates O_2 but *Y* on heating liberates NO_2 and O_2. *X* and *Y* are respectively
(a) $NaNO_3$, KNO_3 (b) $LiNO_3$, $Mg(NO_3)_2$
(c) $NaNO_3$, $Mg(NO_3)_2$ (d) $Mg(NO_3)_2$, $NaNO_3$

8. Main pollutants release from iron and steel industry are
(a) only SO_2 (b) only CO_2
(c) only CO (d) all of these.

9. The standard heat of combustion of Al is –837.8 kJ mol^{-1} at 25°C. If Al reacts with O_2 at 25°C, which of the following releases 250 kJ of heat?

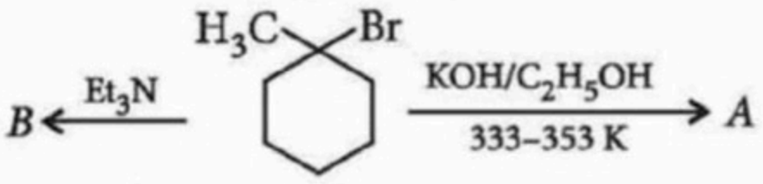
(a) The reaction of 0.624 mol of Al.
(b) The formation of 0.624 mol of Al_2O_3.
(c) The reaction of 0.312 mol of Al.
(d) The formation of 0.150 mol of Al_2O_3.

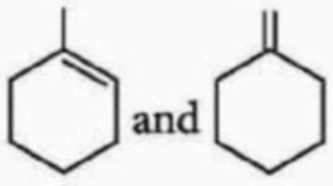
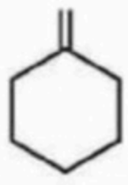
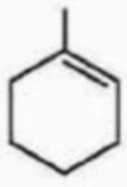
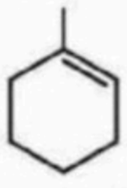
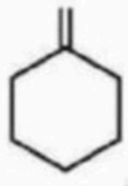
10. The dipole moment of chlorobenzene,  is 1.5 D.

The dipole moment of  is

(a) 2.86 D (b) 2.25 D (c) 1.5 D (d) 0 D

11. The major organic products *A* and *B* in the given reactions are respectively



(a)  and
(b)  and 
(c)  and 
(d)  and 

12. How can the given reaction is made to proceed in forward direction?

$2B(OH)_3 + 2NaOH \rightleftharpoons NaBO_2 + Na[B(OH)_4] + 2H_2O$

(a) Addition of *cis*-1, 2-diol
(b) Addition of borax
(c) Addition of *trans*-1, 2-diol
(d) Addition of Na_2HPO_4

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Buffer system of carbonic acid and sodium bicarbonate is used for the precipitation of hydroxides of third group elements.
Reason : It maintains the pH to a constant value, about 7.4.

14. **Assertion :** In BrF_3, axial fluorine atoms are bent towards the equatorial fluorine.
Reason : Repulsion of lone pairs on equatorial fluorine is stronger as compared to on axial fluorine.

15. **Assertion :** Hydrogen and deuterium are both present in ordinary dihydrogen.
Reason : Heavy hydrogen or deuterium was separated from liquid hydrogen by fractional distillation by H.C. Urey.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. When sulphur in the form of S_8 is heated at 900 K, the initial pressure of 1 atm falls by 29% at equilibrium. This is because of conversion of some S_8 into S_2. The value of equilibrium constant for this reaction is
(a) 2.55 (b) 9.9×10^{-3}
(c) 11×10^{-2} (d) 1.89

17. For a 3*s*-orbital, $\psi(3s) = \frac{1}{9\sqrt{3}}\left(\frac{1}{a_0}\right)^{1/2}(6 - 6\sigma + \sigma^2)e^{-\sigma/2}$ where, $\sigma = \frac{2Zr}{3a_0}$. What is the maximum radial distance of node from nucleus?

(a) $\frac{2}{3}\frac{(3+\sqrt{3})a_0}{Z}$ (b) $\frac{3}{2}\frac{(3+\sqrt{3})a_0}{Z}$
(c) $\frac{3}{2}\frac{(3-3\sqrt{3})a_0}{Z}$ (d) $\frac{3}{2}\frac{(3-\sqrt{3})a_0}{Z}$

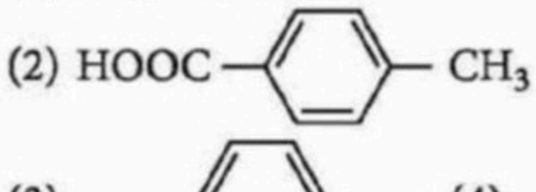
18. A flask of 1 L having $NH_{3(g)}$ at 2.0 atm and 200 K is connected with another flask of volume 800 mL having $HCl_{(g)}$ at 8 atm and 200 K through a narrow tube of negligible volume. The two gases react to form $NH_4Cl_{(s)}$ with evolution of 43 kJ mol^{-1} of heat. If heat capacity of $HCl_{(g)}$ at constant volume is 20 J K^{-1} mol^{-1} and neglecting heat capacity of flask, and volume of solid NH_4Cl formed, then final temperature in flask is
(Assume $R = 0.08$ L atm K^{-1} mol^{-1})
(a) 977.27 K (b) 1177.27 K
(c) 1077.27 K (d) 1277.27 K

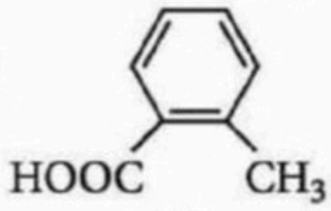
At least half of Earth's Oxygen Comes from the Ocean

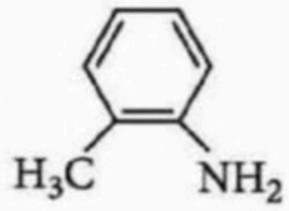
Microscopic, single celled photosynthetic micro-organisms called phytoplankton live near the surface of the water, drift with the currents, and generally do what plants do-make oxygen as a by-product by taking in sunlight and carbon dioxide.

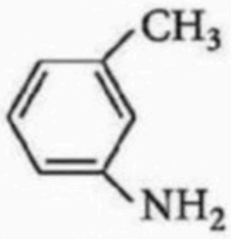
19. The compounds in which the $-CH_3$ group causing decrease in acid strength and increase in basic strength are respectively

(1) CH_3-COOH

(2) 

(3) 

(4) 

(5) 

(a) 3 and 5 (b) 1 and 5

(c) 3 and 4 (d) 2 and 5

More than One Options Correct Type

20. The values of two lattice energies are given below :

NaF – 915 kJ mol^{-1}; MgO – 3933 kJ mol^{-1}

Which of the following correct statements help to explain the difference between these two values?

(a) In each of these compounds, the ions are isoelectronic.

(b) The attraction between doubly charged ions is about four times than that between singly charged ions.

(c) The interionic distance in NaF is greater than that in MgO.

(d) The interionic distance in NaF is smaller than that in MgO.

21. Which of the following reactions will give both gases (X) and (Y)?

$Na_2C_2O_4 + H_2SO_4 \longrightarrow (A) + Na_2SO_4$

$\downarrow \Delta$

$H_2O + (X) + (Y)$

$\downarrow$ Burns with yellow flame — $\downarrow$ Turns lime water milky

(a) $H_2C_2O_4 \xrightarrow{\Delta}$ (b) $FeC_2O_4 \xrightarrow{\Delta}$

(c) $HCOONa \xrightarrow{\Delta}$ (d) $HCOOAg \xrightarrow{\Delta}$

22. The van der Waals' parameters a and b for two gases are given as,

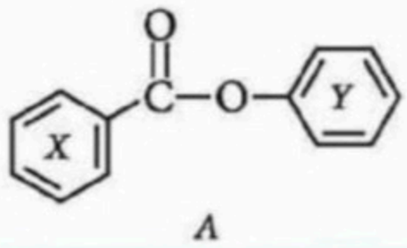
Gas A	Gas B
$a = 6.5\ dm^6\ bar/mole^2$	$a = 18.0\ dm^6\ bar/mole^2$
$b = 0.056\ dm^3\ mole^{-1}$	$b = 0.011\ dm^3\ mole^{-1}$

Which of the following options are incorrect?

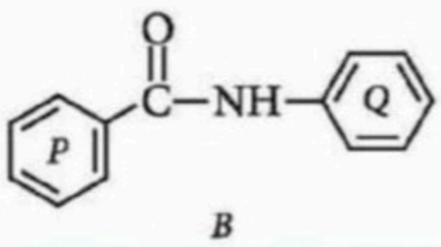
(a) $(V_c)_A > (V_c)_B$ (b) $(P_c)_A > (P_c)_B$

(c) $(T_c)_A > (T_c)_B$ (d) $(P_c)_A = (P_c)_B$

23. Which of the following statements are correct about the electrophilic substitution reactions in given compounds A and B?



A



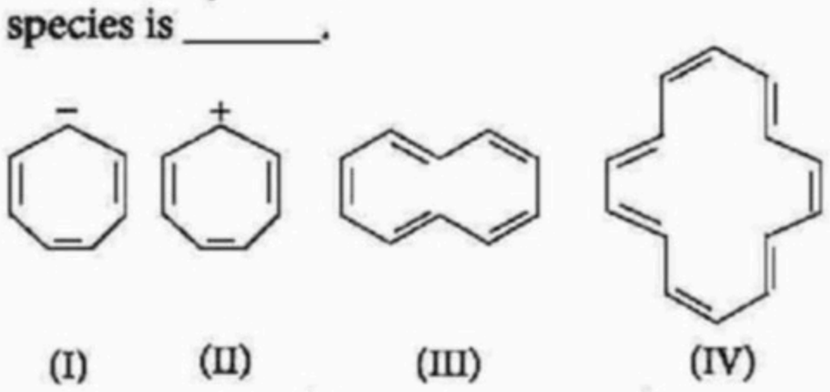
B

(a) Compound *A* is more reactive than compound *B*.
(b) In *A*, ring *Y* will take part in electrophilic substitution reaction.
(c) In *B*, ring *Q* will take part in electrophilic substitution reaction.
(d) Compound *B* is more reactive than compound *A*.

Numerical Value Type

24. In 1 L saturated solution of AgCl [K_{sp}(AgCl) = 1.6×10^{-10}], 0.1 mol of CuCl [K_{sp}(CuCl) = 1.0×10^{-6}] is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x}. The value of x is _____.

25. From the given species, the number of aromatic species is _____.



26. To an evacuated vessel with movable piston under external pressure of 1 atm, 0.1 mol of He and 1.0 mol of an unknown compound (vapour pressure = 0.68 atm at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litres) of the gases at 0°C is _____.

Matrix Match Type

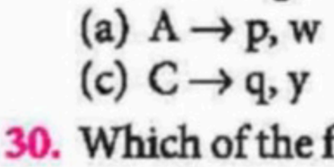
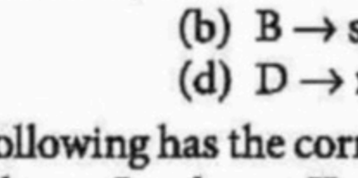
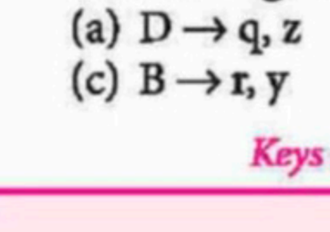
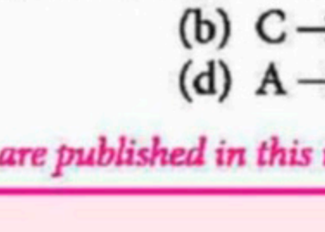
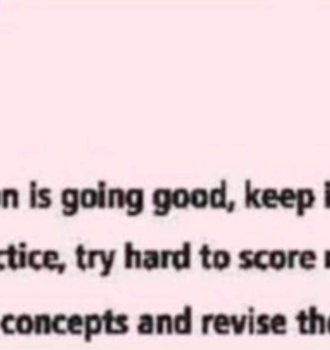
Answer the following questions (27 and 28) by appropriately matching the columns based on the information given in the passage :
Columns 1, 2 and 3 contain number of moles, volumes at STP and number of atoms, respectively.

Column 1	Column 2	Column 3
(I) 0.125	(i) 7840 mL	(P) 13.25×10^{23}
(II) 0.35	(ii) 11.2 dm^3	(Q) 6.32×10^{23}
(III) 1.1	(iii) 2.8 L	(R) 6.023×10^{23}
(IV) 0.50	(iv) 24640 cc	(S) 3.011×10^{23}

27. The correct combination for 16 g of NO_2 is
(a) (I) → (ii) → (R) (b) (II) → (iii) → (S)
(c) (II) → (i) → (Q) (d) (IV) → (iii) → (P)

28. For 32 g of sulphur, correct combination will be
(a) (I) → (ii) → (P) (b) (I) → (iii) → (R)
(c) (II) → (iii) → (Q) (d) (III) → (iv) → (S)

Answer the following questions (29 and 30) by appropriately matching the columns based on the information given in the passage :
Columns 1, 2 and 3 contain reactants, products and type of reactions, respectively.

Column 1	Column 2	Column 3
(A) $2CH_2=CH_2 \xrightarrow{HF}$	(p) $CH_3CH_2CH=CH_2$	(w) Dimerisation
(B) 	(q) 	(x) Intercon-version
(C) 	(r) 	(y) Isomerisation
(D) 	(s)	(z) Alkylation

29. Which of the following has the correct combination considering column-I, column-II and column-III ?
(a) A → p, w (b) B → s, w
(c) C → q, y (d) D → r, x

30. Which of the following has the correct combination considering column-I, column-II and column-III ?
(a) D → q, z (b) C → s, y
(c) B → r, y (d) A → s, w

Keys are published in this issue. Search now!

CHECK YOUR PERFORMANCE

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

If your score is

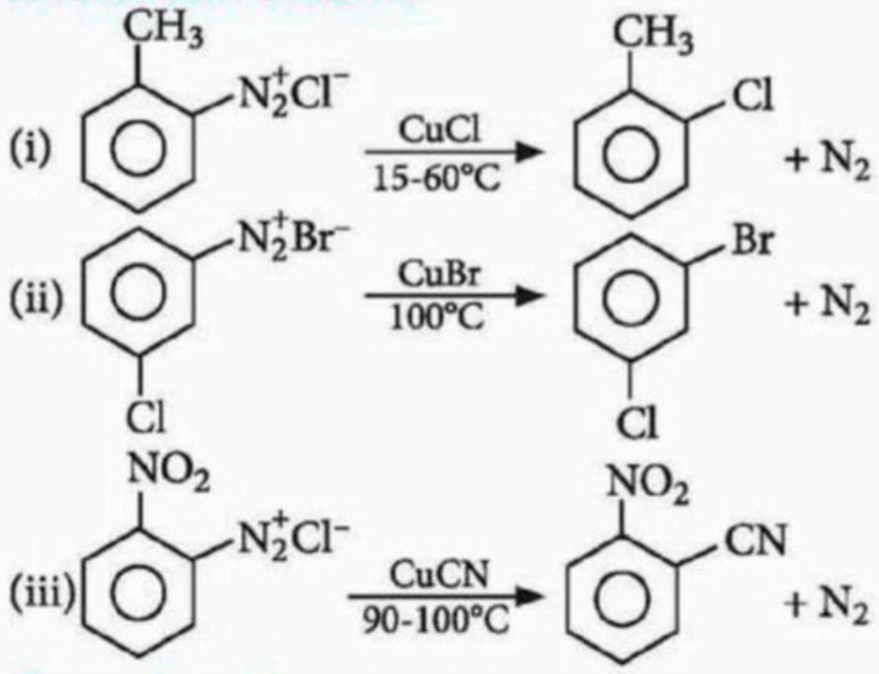
> 80%	Your preparation is going good, keep it up to get high score.
60-80%	Need more practice, try hard to score more next time.
<60%	Stress more on concepts and revise thoroughly.

CONCEPT BOOSTER

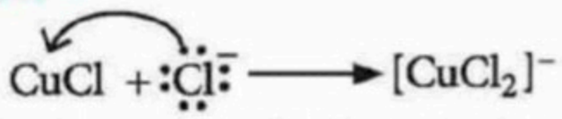
Hello dear students! Hope you all are fine. Those who have appeared for the board examinations, I believe that you did your best. Now it's hard time that you start identifying your weak areas. I would suggest you to study topicwise and not chapterwise as of now. Keeping this in mind I have present this article with some intricate and conceptual topics. Hope you will like it. All the best!

*Arunava Sarkar

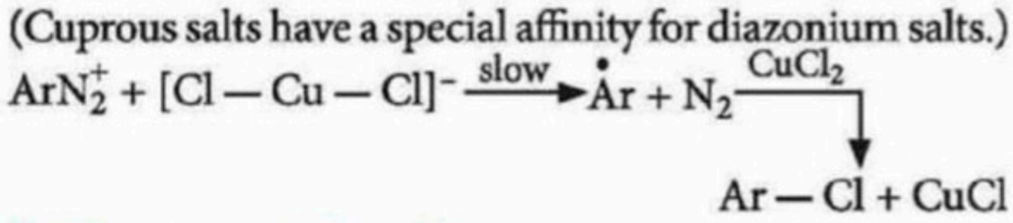
WHAT YOU KNOW?



Do you know?



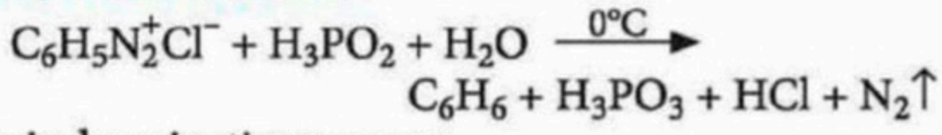
(Cuprous salts have a special affinity for diazonium salts.)



What you must know?

The above reactions are Sandmeyer reactions. If you take Cu powder then it will be named as Gattermann reaction.

WHAT YOU KNOW?

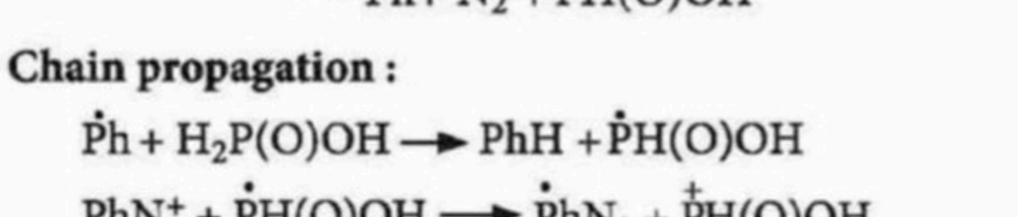


This is deamination process.

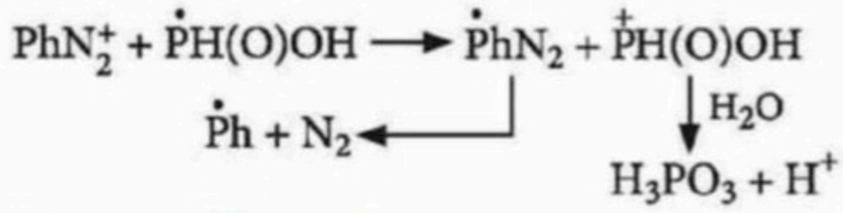
Do you know?

The above reaction takes place via free radical mechanism.

Chain initiation :



Chain propagation :

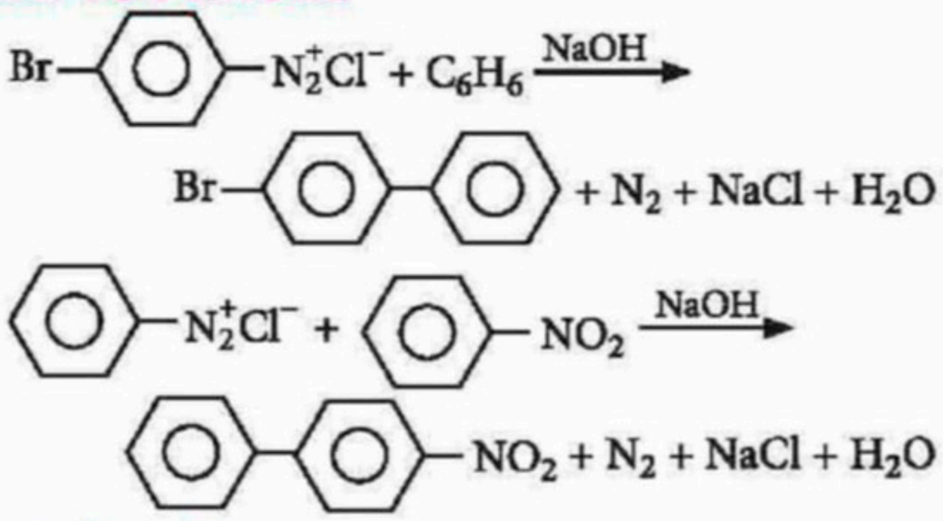


What you must know?

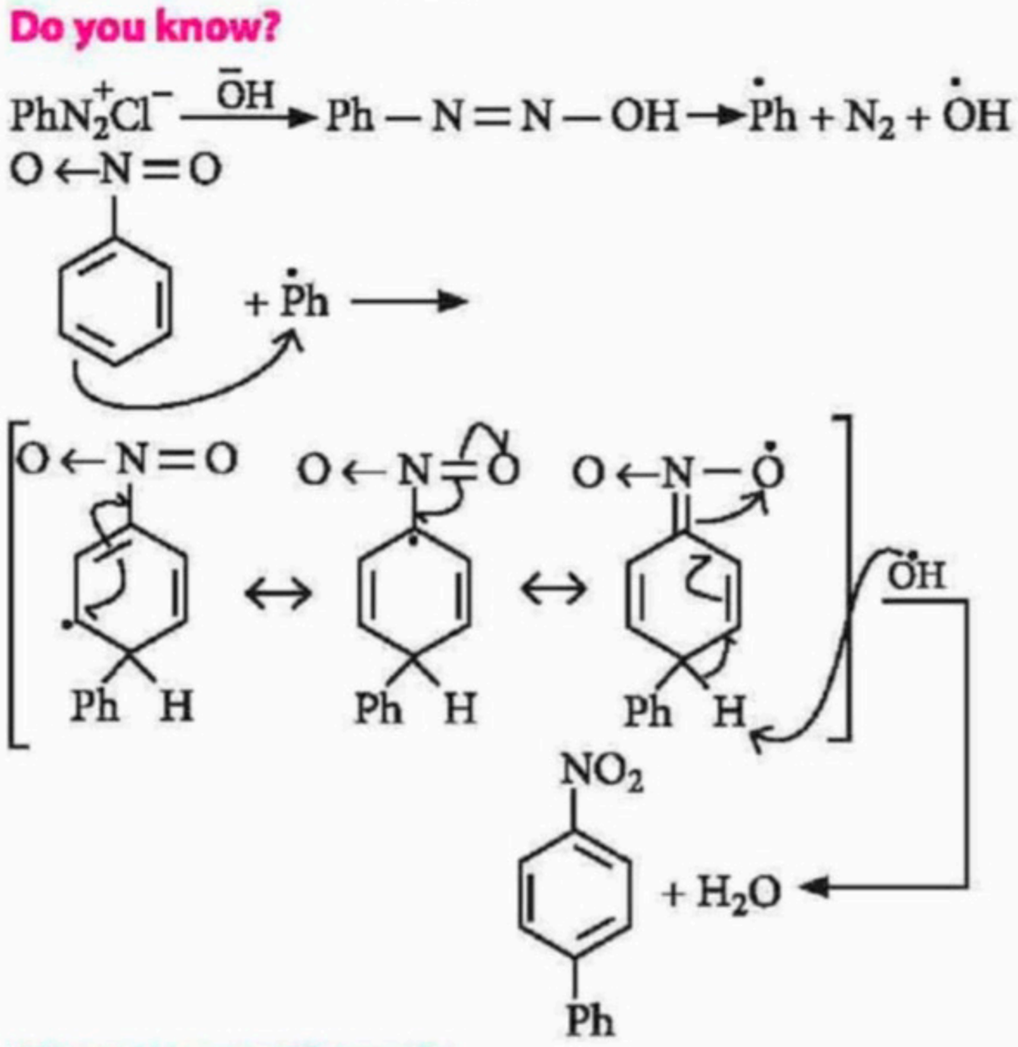
$NaBH_4$/ethanol can also be used for replacement of diazonium group by hydrogen.

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

WHAT YOU KNOW?



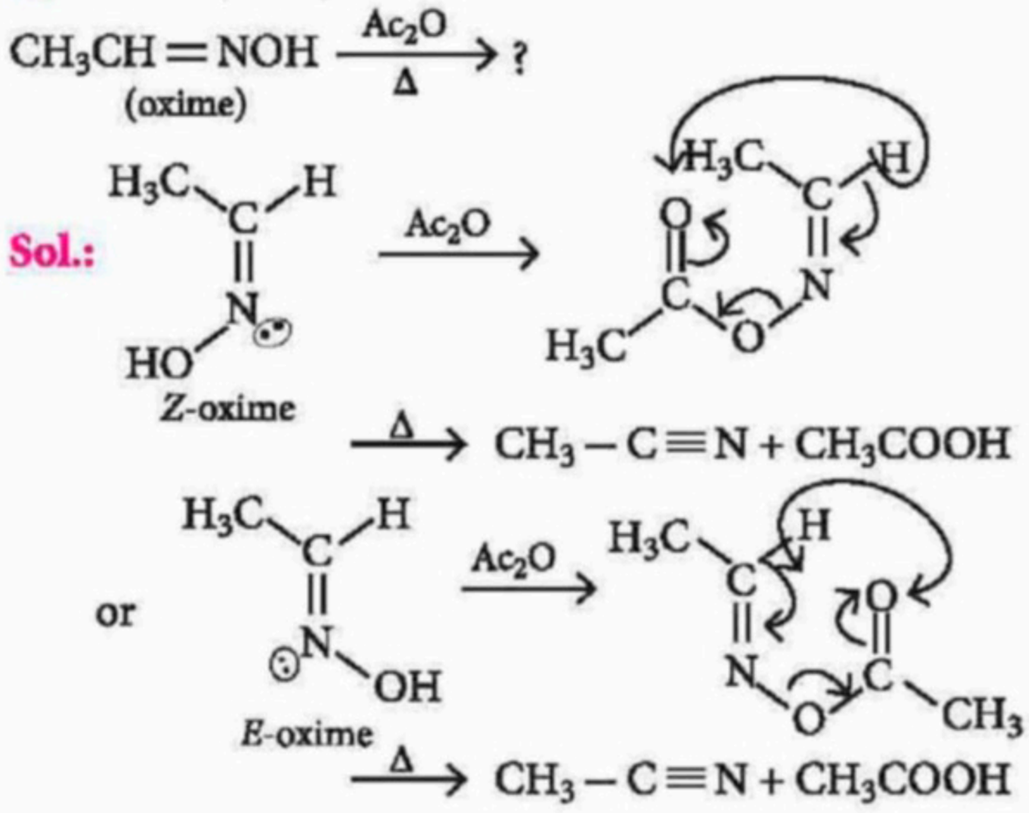
Do you know?



What you must know?

The above reactions are Gomberg reactions. It is to be remembered that whatever becomes the nature of a substituent in the second component, *ortho* or *para* substitution always occurs predominantly.

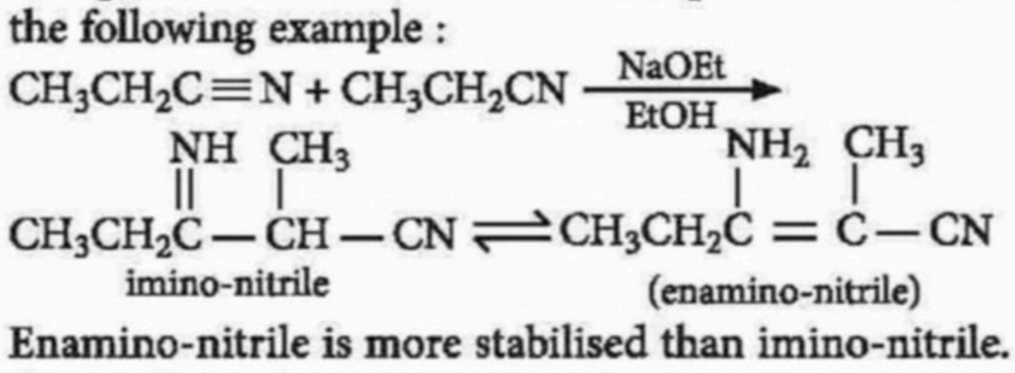
Q. Identify the product.



Do you know?

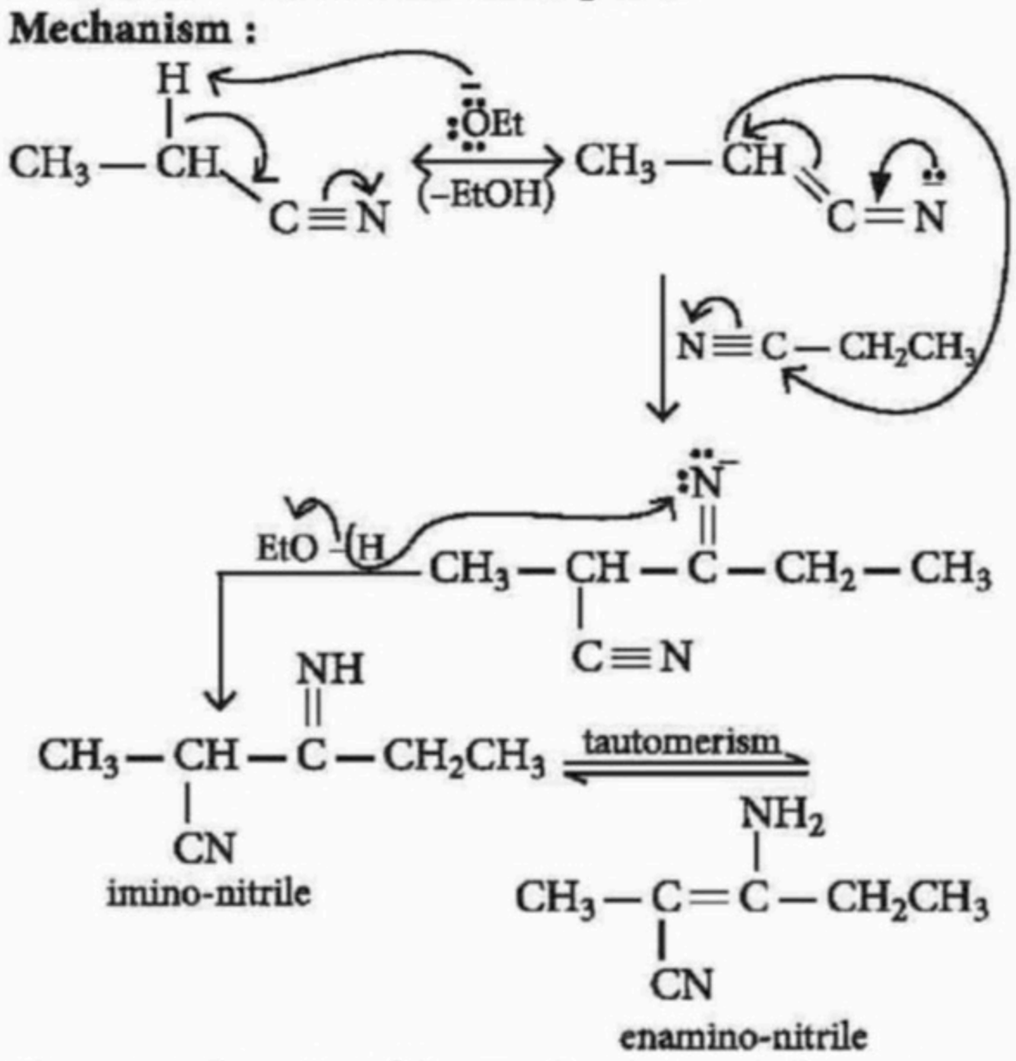
Thorpe nitrile condensation or Thorpe reaction :

Base catalysed condensation between two cyanide molecules where α-carbon of one molecule combines to the cyano carbon of the other is popularly known as Thorpe nitrile condensation or Thorpe reaction. Take the following example :

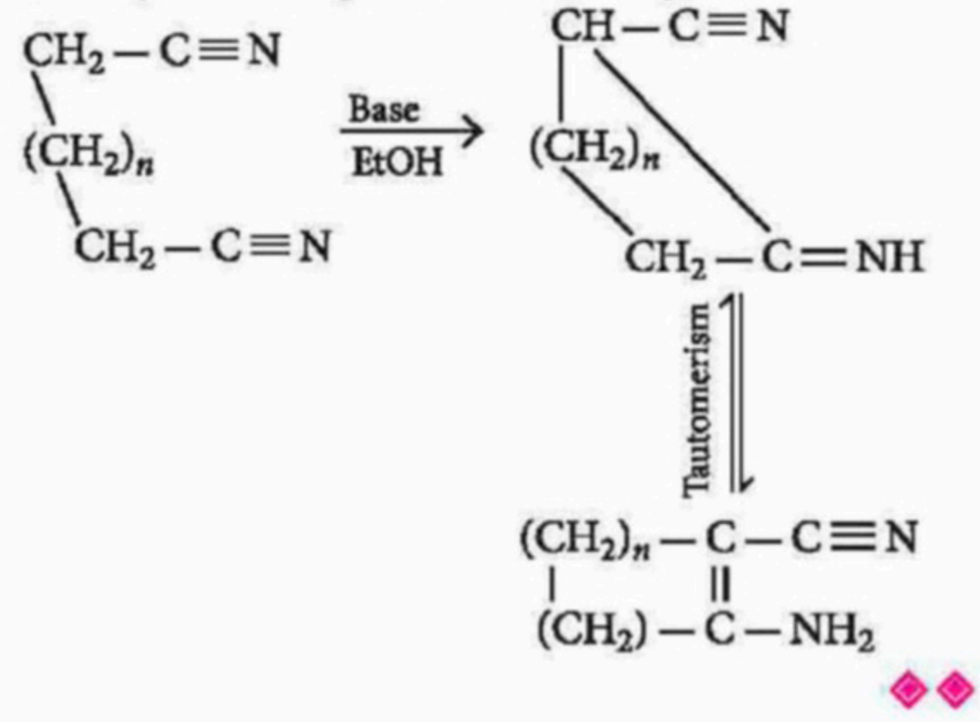


Enamino-nitrile is more stabilised than imino-nitrile. Hence, the tautomerism takes place.

Mechanism :



Do remember that this reaction is carried out intramolecularly also, and in that case this reaction is called Thorpe-Ziegler reaction and this is a useful method for preparing 5 to 8 large membered ring.



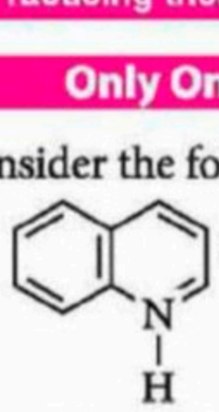
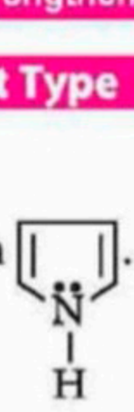
GET SET GO for JEE

with exclusive and brain storming MCQs

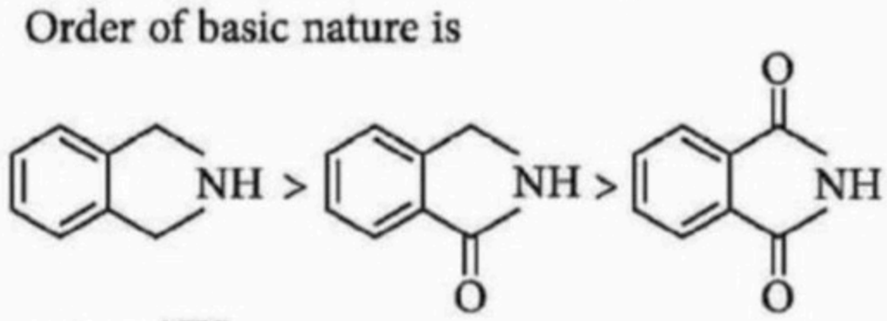
Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

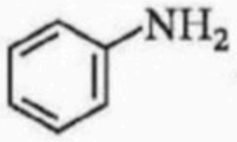
Only One Option Correct Type

1. Consider the following,

I.  is more basic than  .

II. Order of basic nature is



III.  is more basic than ammonia.

(a) All statements are correct.

(b) II is wrong while I and III are correct statements.

(c) I and III are wrong while II is correct statement.

(d) Statements I and II are correct while III is wrong.

2. In a given set of the reactions, acetic acid yielded a product *C*.

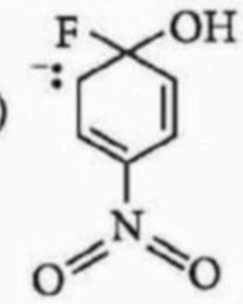
$$CH_3COOH \xrightarrow{PCl_5} A \xrightarrow[AlCl_3]{C_6H_6} B \xrightarrow{C_2H_5MgBr/H_3O^+} C$$

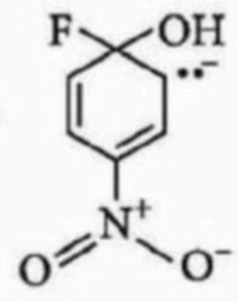
The product *C* would be

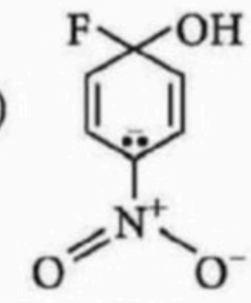
(a) $CH_3CH(OH)C_2H_5$ (b) $CH_3COC_6H_5$

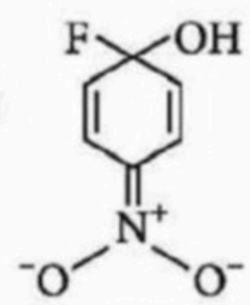
(c) $CH_3CH(OH)C_6H_5$ (d) $CH_3-\underset{\displaystyle C_2H_5}{\overset{}{\underset{|}{C}}}(OH)C_6H_5$

3. Which resonance form is not possible in the nucleophilic addition of OH^- ion to *para*-fluoronitrobenzene?

(a) 

(b) 

(c) 

(d) 

4. The emf of a Daniell cell at 298 K is E_1,

$Zn \mid ZnSO_4(0.01\ M) \parallel CuSO_4\ (1.0\ M) \mid Cu$

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the emf is changed to E_2.

What is the relationship between E_1 and E_2?

(a) $E_2 = 0 \approx E_1$ (b) $E_1 > E_2$
(c) $E_1 < E_2$ (d) $E_1 = E_2$

5. P_4S_3 is used with $KClO_3$ in "strike any-where" matches. The number of 'P—P' bonds and 'S—P' bonds in P_4S_3 are respectively

	'P—P' bond	'S—P' bond
(a)	6	3
(b)	3	6
(c)	1	2
(d)	0	6

6. Which of the following statements is incorrect?
(a) Natural starch has approximately 10-20% of amylose and 80-90% of amylopectin.
(b) Amylose is water soluble and gives blue colour with iodine.
(c) Amylopectin is a branched chain polysaccharides insoluble in water and does not give blue colour with iodine.
(d) Starch is not hydrolysed by enzyme amylase present in saliva.

7. I. $[MnCl_6]^{3-}$, $[FeF_6]^{3-}$ and $[CoF_6]^{3-}$ are paramagnetic having four, five and four unpaired electrons respectively.
II. Valence bond theory gives a quantitative interpretation of the thermodynamic stabilities of coordination compounds.
III. The crystal field splitting Δ_o, depends upon the field produced by the ligand and charge on the metal ion.
Among the following correct statements are
(a) only I and II (b) only I and III
(c) I, II and III (d) only II and III.

8. Which of the following relations is/are correct according to Freundlich adsorption isotherm?
(i) x/m = constant
(ii) x/m = constant $\times p^{1/n}$ $(n > 1)$
(iii) x/m = constant $\times p^{n}$ $(n > 1)$
(a) All are correct. (b) Only (i) and (ii)
(c) Only (ii) (d) Only (iii)

9. Which of the following expressions is correct for packing fraction of NaCl if the ions along the face are diagonally removed ?

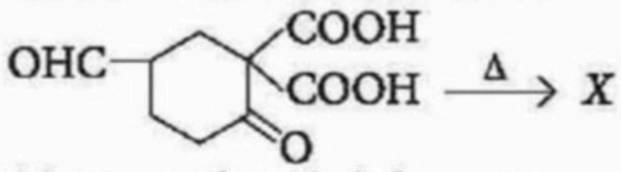
(a) $\dfrac{\frac{13}{3}\pi r_-^3 + \frac{16}{3}\pi r_+^3}{8(r_+ + r_-)^3}$ (b) $\dfrac{\frac{13}{3}\pi r_-^3 + \frac{4}{3}\pi r_+^3}{8(r_+ + r_-)^3}$

(c) $\dfrac{\frac{16}{3}\pi r_-^3 + \frac{13}{3}\pi r_+^3}{8(r_+ + r_-)^3}$ (d) $\dfrac{\frac{4}{3}\pi r_-^3 + \frac{13}{3}\pi r_+^3}{8(r_+ + r_-)^3}$

10. Consider the following isolation/purification processes.
I. Heating impure metal with I_2 at 150–200°C and passing the resulting volatile iodide on hot tungsten filament at 1400°C to get the pure metal.
II. Heating the sulphide ore in air until a part is converted to oxide and then further heating in the absence of air to let the oxide react with unchanged metal sulphide to get the metal.
III. Electrolysis of the molten electrolyte containing metal oxide and cryolite or fluorspar to obtain the metal.
The processes used for obtaining aluminium, titanium and lead are respectively
(a) I, II and III (b) II, III and I
(c) III, I and II (d) II, I and III.

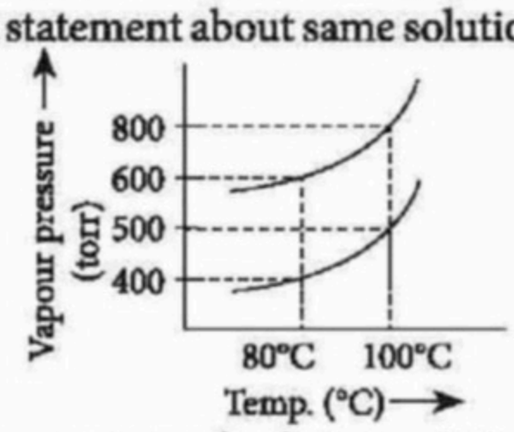
More Than One Options Correct Type

11. Which is not correct about *X*?



(a) *X* can show haloform test.
(b) *X* can give brisk effervescence with $NaHCO_3$.
(c) *X* cannot show Fehling's test.
(d) *X* contains one —CHO, one $>C=O$ group and one — COOH group.

12. The vapour pressure of an ideal solution of benzene and toluene is 550 torr at 80°C then what would be the correct statement about same solution at 100°C?



(a) Vapour pressure of solution = 725 torr.
(b) At 725 torr pressure and 90°C, no vapour will form.

UNSCRAMBLED WORDS

MARCH 2020

1-e-FLAVOPROTEINS	2-i- GANGLIOSIDES
3-a-MASER	4-g- MONTMORILLONITE
5-b-OSTEOMALACIA	6-j- SHERARDIZING
7-h-AMPHETAMINE	8-f- LYSOLECITHIN
9-d-NEMATOCIDE	10-c-BUFOTOXIN

(c) Composition of vapours is $\frac{2}{11}$ and $\frac{9}{11}$.

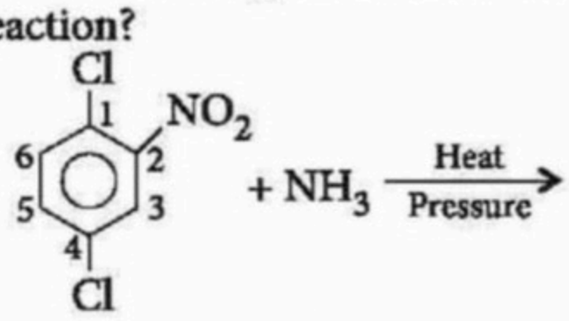
(d) Composition of liquid remain same at equilibrium condition at any temperature.

13. Fenton's reagent is, $X + H_2O_2$. X combines readily with Y and H_2O to form crystals of Mohr's salt. X can be made in laboratory from Kipp's waste. When Kipp's waste is heated in the presence of O_2 and water, Z is also produced along with X. The reaction of X with $KMnO_4$ in the presence of H_2SO_4 also gives Z. Identify the correct match.

(a) $X = FeSO_4$ (b) $Z = Fe_2(SO_4)_3$

(c) $Y = (NH_4)_2SO_4$ (d) $Z = FeSO_4$

14. Which of the following statements is false regarding given reaction?



(a) No reaction is possible because —Cl is present on benzene ring.

(b) A nucleophilic substitution will take place in which both —Cl will be replaced by two $-NH_2$ groups.

(c) A nucleophilic substitution will take place in which only —Cl attached on C_1 will be replaced by $-NH_2$.

(d) A nucleophilic substitution will take place in which only —Cl attached on C_4 will be replaced by $-NH_2$.

15. When the temperature of a reaction is changed from T_1 to T_2, half-life is found to decrease. Thus,

(a) $T_2 > T_1$

(b) the reaction is exothermic

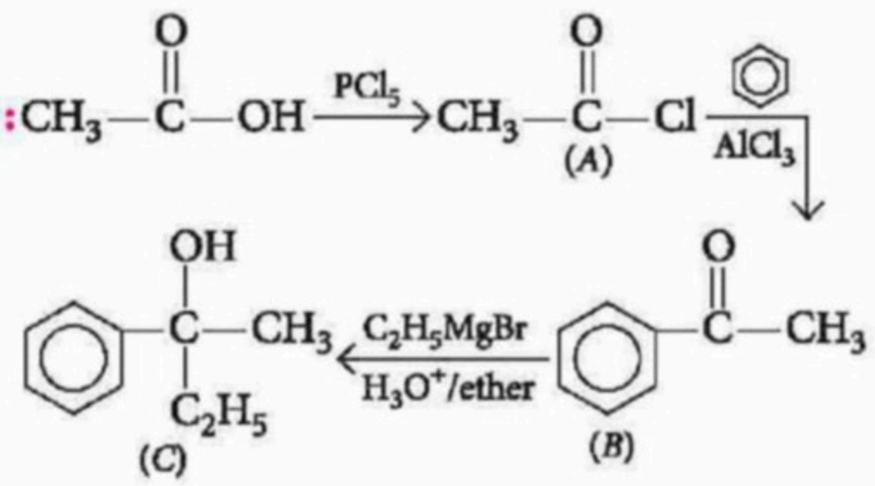
(c) the reaction is endothermic

(d) the reaction can be exothermic or endothermic.

SOLUTIONS

1. (d)

2. (d) :



3. (a)

4. (b) : Daniell cell reaction :

$Cu^{2+} + Zn \rightarrow Zn^{2+} + Cu$; $n = 2$

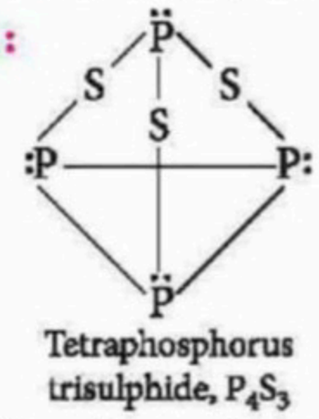
$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$E_1 = E^{\circ}_{cell} - \frac{0.0591}{2} \log \frac{0.01}{1.0}$$

$$E_2 = E^{\circ}_{cell} - \frac{0.0591}{2} \log \frac{1.0}{0.01}$$

On increasing $[Zn^{2+}]$ and decreasing $[Cu^{2+}]$, E_2 becomes less than E_1 *i.e.*, $E_1 > E_2$.

5. (b) :



Tetraphosphorus trisulphide, P_4S_3

"S—P" bonds = 6 "P—P" bonds = 3

6. (d)

7. (b) : Valence bond theory does not give a quantitative interpretation of the thermodynamic or kinetic stabilities of coordination compounds.

8. (c)

9. (a) : Effective number of remaining Cl^-

$$= 4 - \left(2 \times \frac{1}{8} + \frac{1}{2}\right) = \frac{13}{4}$$

Effective number of $Na^+ = 4$

$$\text{Packing fraction} = \frac{\text{Occupied volume}}{\text{Total volume}}$$

$$= \frac{\frac{13}{4} \times \frac{4}{3}\pi r_-^3 + 4 \times \frac{4}{3}\pi r_+^3}{8(r_+ + r_-)^3} = \frac{\frac{13}{3}\pi r_-^3 + \frac{16}{3}\pi r_+^3}{8(r_+ + r_-)^3}$$

10. (c) : I. $Ti_{(s)}$ (impure) + $2I_{2(g)} \xrightarrow{150\text{–}250^\circ C} TiI_4$

TiI_4 (volatile) $\xrightarrow[\text{tungsten filament}]{1400^\circ C} Ti_{(s)}$ (pure) + $2I_{2(g)}$

II. $2PbS + 3O_2 \xrightarrow{\Delta} 2PbO + 2SO_2$

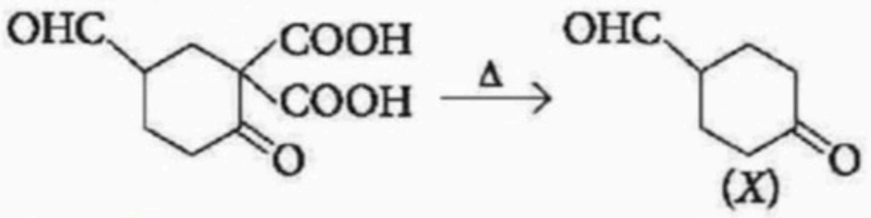
$PbS + 2PbO \xrightarrow[\text{temp.}]{\text{high}} 3Pb + SO_2$

III. Cathode : Al^{3+} (melt) + $3e^- \longrightarrow Al_{(l)}$

Anode : $C_{(s)} + O^{2-}$ (melt) $\longrightarrow CO_{(g)} + 2e^-$

$C_{(s)} + 2O^{2-}$ (melt) $\longrightarrow CO_{2(g)} + 4e^-$

11. (a,b,c,d) :



12. (a,b) : $p = p^{\circ}_A x_A + p^{\circ}_B x_B$ (x_B = mole fraction of benzene)

$550 = 400 \times (1 - x_B) + 600(x_B)$

$150 = (600 - 400)x_B$

$\frac{150}{200} = \frac{3}{4} = x_B \; ; x_A = \frac{1}{4}$

At 100 °C mole fraction will be same initially but get changed at equilibrium.

$$P = \frac{1}{4} \times 500 + \frac{3}{4} \times 800 = 125 + 600 = 725 \text{ torr}$$

$x_A p^{\circ}_A = y_A P$

$$\frac{1}{4} \times 500 = y_A \times 725 \Rightarrow y_A = \frac{125}{725}$$

So, $y_A = \frac{5}{29}$ and $y_B = \frac{24}{29}$

At 90°C, mole fraction will be same initially but get changed at equilibrium.

$500 < P < 725$

So, at $P = 725$ only liquid state exists.

13. (a,b,c) : Fenton's reagent is, $FeSO_4 + H_2O_2$.

$$\underset{(X)}{FeSO_4} + \underset{(Y)}{(NH_4)_2SO_4} + 6H_2O \rightarrow FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$$

$$FeS_2 + O_2 + H_2O \rightarrow \underset{(X)}{FeSO_4} + \underset{(Z)}{Fe_2(SO_4)_3} + H_2SO_4$$

$$\underset{(X)}{10FeSO_4} + 2KMnO_4 + 8H_2SO_4 \rightarrow \underset{(Z)}{5Fe_2(SO_4)_3} + 2MnSO_4 + 8H_2O$$

14. (a,b,d) : The —Cl group present in the *o*- and *p*-positions to the electron withdrawing group is activated towards nucleophilic substitution, hence, only —Cl present on the *o*- and/or *p*-position to the $-NO_2$ group will be replaced.

15. (a, d) : Half-life of a reaction will decrease only when rate constant increases. Rate constants of all reactions (endothermic or exothermic) increase on increasing temperature (except for the reaction, $2NO + O_2 \rightarrow 2NO_2$).

****

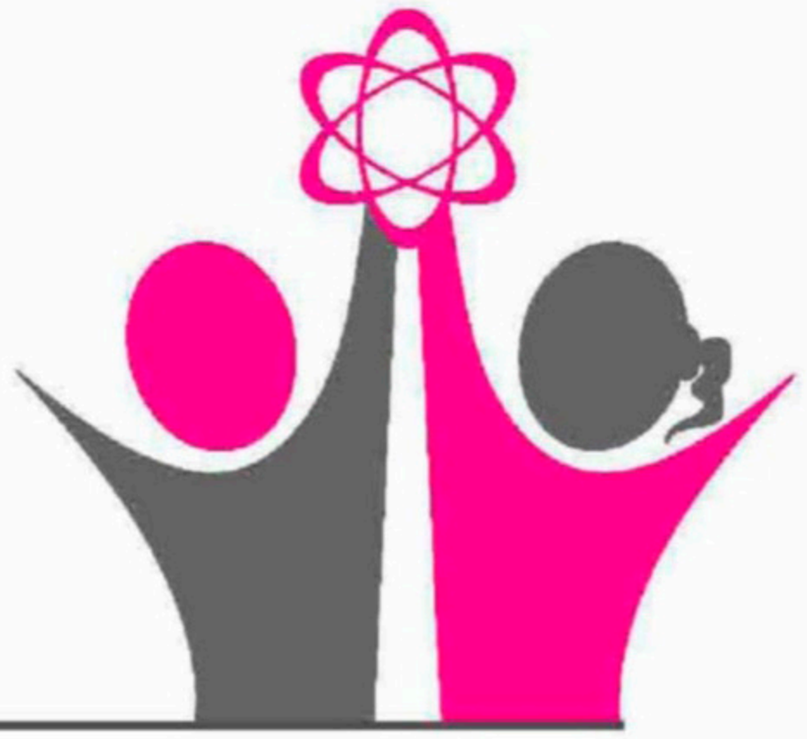
UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I		Column II
1. HANESPLIC	(a)	A hydrated Mg-Al-Fe silicate clay. Used as a catalyst, thermal insulator and in agriculture as a rooting medium and soil additive.
2. OPTHYRIXTO	(b)	It is a term applied to solids e.g., during the process of magnetization of iron.
3. ITEREVUICML	(c)	It is an impure Al_2O_3 (corundum) containing some iron oxide. It is used as a polishing agent and abrasive.
4. YRRME	(d)	The isothermal gel-sol transformation brought about by shaking or other mechanical means. It may be regarded as a packing phenomenon.
5. ANDBL	(e)	Phospholipids similar to lecithins except that ethanolamine or serine replaces choline in the molecule. They are found in all animals and vegetable tissues.
6. AIMOERXLAHTP	(f)	Disease which is caused due to the deficiency of vitamin A.
7. SYHSITREES	(g)	It is a white crystalline substance which turns red when exposed to air. It is used in analytical detection of carbohydrates.
8. OLIRONC	(h)	It refers to any non-irritating chemical such as olive oil.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Names of solution senders will be published in next issue.

CBSE BOARD
SOLVED PAPER 2020*



GENERAL INSTRUCTIONS

(a) All questions are compulsory.
(b) Section A: Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each.
(c) Section B: Q.no. 21 to 27 are short answer questions and carry 2 marks each.
(d) Section C: Q.no. 28 to 34 are long answer questions and carry 3 marks each.
(e) Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
(f) There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(g) Use log tables if necessary, use of calculators is not allowed.

Time Allowed : 3 hours | Maximum Marks : 70

SECTION A

Read the given passage and answer the questions number 1 to 5 that follow :

The substitution reaction of alkyl halide mainly occurs by S_N1 or S_N2 mechanism. Whatever mechanism alkyl halides follow for the substitution reaction to occur, the polarity of the carbon halogen bond is responsible for these substitution reactions. The rate of S_N1 reactions are governed by the stability of carbocation whereas for S_N2 reactions steric factor is the deciding factor. If the starting material is a chiral compound, we may end up with an inverted product or racemic mixture depending upon the type of mechanism followed by alkyl halide. Cleavage of ethers with HI is also governed by steric factor and stability of carbocation, which indicates that in organic chemistry, these two major factors help us in deciding the kind of product formed.

1. Predict the stereochemistry of the product formed if an optically active alkyl halide undergoes substitution reaction by S_N1 mechanism.
2. Name the instrument used for measuring the angle by which the plane polarised light is rotated.
3. Predict the major product formed when 2-bromopentane reacts with alcoholic KOH.
4. Give one use of CHI_3.
5. Write the structures of the products formed when anisole is treated with HI.

Questions number 6 to 10 are one word answers :

6. Identify which liquid will have a higher vapour pressure at 90°C if the boiling points of two liquids *A* and *B* are 140°C and 180°C, respectively.
7. Out of zinc and tin, whose coating is better to protect iron objects?
8. Will the rate constant of the reaction depend upon *T* if the E_{act} (activation energy) of the reaction is zero?
9. Give the structure of the monomer of PVC.
10. Which structural unit present in a detergent makes it non-biodegradable?

Questions number 11 to 15 are multiple choice questions :

11. Out of the following, the strongest base in aqueous solution is

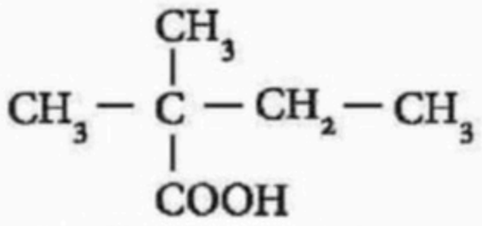
(a) methylamine (b) dimethylamine
(c) trimethylamine (d) aniline.

12. Iodoform test is not given by
(a) ethanol (b) ethanal
(c) pentan-2-one (d) pentan-3-one.

13. Out of the following transition elements, the maximum number of oxidation states are shown by
(a) Sc ($Z = 21$) (b) Cr ($Z = 24$)
(c) Mn ($Z = 25$) (d) Fe ($Z = 26$).

14. Hardening of leather in tanning industry is based on
(a) electrophoresis (b) electro-osmosis
(c) mutual coagulation (d) Tyndall effect.

15. What is the correct IUPAC name of the given compound?



(a) 2,2-Dimethylbutanoic acid
(b) 2-Carboxyl-2-methylbutane
(c) 2-Ethyl-2-methylpropanoic acid
(d) 3-Methylbutanecarboxylic acid

For questions number 16 to 20, two statements are given–one labelled Assertion (A) and the other labelled Reason(R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below :

(i) Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).
(ii) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is **not** the correct explanation of the Assertion (A).
(iii) Assertion (A) is correct, but Reason (R) is incorrect statement.
(iv) Assertion (A) is incorrect, but Reason (R) is correct statement.

16. **Assertion (A) :** Au and Ag are extracted by leaching their ores with a dil. solution of NaCN.
Reason (R) : Impurities associated with these ores dissolve in NaCN.

17. **Assertion (A) :** F — F bond in F_2 molecule is weak.
Reason (R) : F atom is small in size.

18. **Assertion (A) :** Linkage isomerism arises in coordination compounds because of ambidentate ligand.
Reason (R) : Ambidentate ligand like NO_2 has two different donor atoms *i.e.*, N and O.

19. **Assertion (A) :** Sucrose is a non-reducing sugar.
Reason (R) : Sucrose has glycosidic linkage.

20. **Assertion (A) :** The molecularity of the reaction $H_2 + Br_2 \longrightarrow 2HBr$ appears to be 2.
Reason (R) : Two molecules of the reactants are involved in the given elementary reaction.

SECTION B

21. Define the following terms :
(a) Tranquilizers
(b) Antiseptic

OR

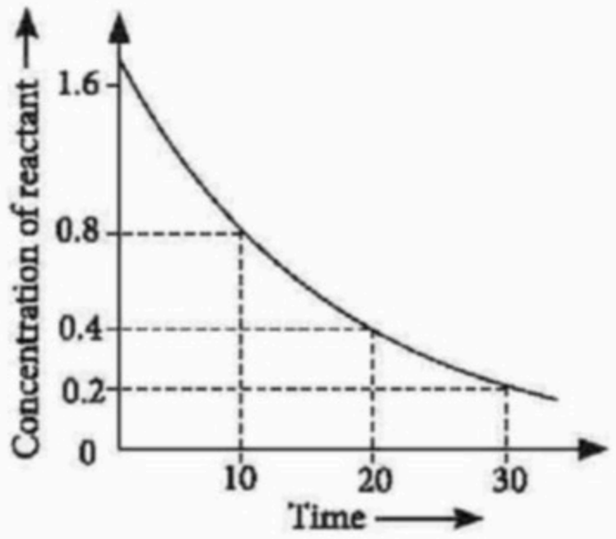
Explain the cleansing action of soaps.

22. For a 5% solution of urea (Molar mass = 60 g/mol), calculate the osmotic pressure at 300 K.
[$R = 0.0821$ L atm K^{-1} mol^{-1}]

OR

Visha took two aqueous solutions – one containing 7.5 g of urea (Molar mass = 60 g/mol) and the other containing 42.75 g of substance *Z* in 100 g of water, respectively. It was observed that both the solutions froze at the same temperature. Calculate the molar mass of *Z*.

23. Analyse the given graph, drawn between concentration of reactant *vs.* time.



(a) Predict the order of reaction.
(b) Theoretically, can the concentration of the reactant reduce to zero after infinite time. Explain.

24. Draw the shape of the following molecules :
(a) $XeOF_4$
(b) BrF_3

25. Give the formulae of the following compounds :
(a) Potassium tetrahydroxidozincate(II)
(b) Hexaammineplatinum(IV) chloride

26. What happens when
(a) propanone is treated with methylmagnesium iodide and then hydrolysed, and

(b) benzene is treated with CH_3COCl in presence of anhydrous $AlCl_3$?

27. Write the names and structures of monomers in the following polymers :

(a) Bakelite (b) Neoprene

SECTION C

28. Give the structures of *A* and *B* in the following sequence of reactions :

(a) $CH_3COOH \xrightarrow[\Delta]{NH_3} A \xrightarrow{NaOBr} B$

(b) $C_6H_5NO_2 \xrightarrow{Fe/HCl} A \xrightarrow[0°-5°C]{NaNO_2+HCl} B$

(c) $C_6H_5N_2^+Cl^- \xrightarrow[\Delta]{CuCN} A \xrightarrow{H_2O/H^+} B$

OR

(a) How will you distinguish between the following pairs of compounds :

(i) Aniline and ethanamine

(ii) Aniline and *N*-methylaniline

(b) Arrange the following compounds in decreasing order of their boiling points :

Butanol, Butanamine, Butane

29. Give the plausible explanation for the following :

(a) Glucose doesn't give 2,4-DNP test.

(b) The two strands in DNA are not identical but are complementary.

(c) Starch and cellulose both contain glucose unit as monomer, yet they are structurally different.

30. Account for the following :

(a) Sulphurous acid is a reducing agent.

(b) Fluorine forms only one oxoacid.

(c) Boiling point of noble gases increases from He to Rn.

OR

Complete the following chemical reactions :

(a) $MnO_2 + 4HCl \longrightarrow$

(b) $XeF_6 + KF \longrightarrow$

(c) $I^-_{(aq)} + H^+_{(aq)} + O_{2(g)} \longrightarrow$

31. Explain the role of the following :

(a) NaCN in the separation of ZnS and PbS.

(b) SiO_2 in the metallurgy of Cu containing Fe as impurity.

(c) Iodine in the refining of Ti.

32. Give three points of difference between physisorption and chemisorption.

33. How will the rate of the reaction be affected when

(a) surface area of the reactant is reduced,

(b) catalyst is added in a reversible reaction, and

(c) temperature of the reaction is increased?

34. Calculate the mass of ascorbic acid (Molar mass = 176 g mol^{-1}) to be dissolved in 75 g of acetic acid, to lower its freezing point by 1.5°C .
(K_f = 3.9 K kg mol^{-1})

SECTION D

35. (a) Calculate $\Delta G°$ for the reaction,

$Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

Given : $E°$ for Zn^{2+}/Zn = –0.76 V and

$E°$ for Cu^{2+}/Cu = +0.34 V

R = 8.314 J K^{-1} mol^{-1}, F = 96500 C mol^{-1}.

(b) Give two advantages of fuel cells.

OR

(a) Out of the following pairs, predict with reason which pair will allow greater conduction of electricity.

(i) Silver wire at 30°C or silver wire at 60°C.

(ii) 0.1 M CH_3COOH solution or 1 M CH_3COOH solution.

(iii) KCl solution at 20°C or KCl solution at 50°C.

(b) Give two points of differences between electrochemical and electrolytic cells.

36. (a) Account for the following :

(i) Copper(I) compounds are white whereas copper(II) compounds are coloured.

(ii) Chromates change their colour when kept in an acidic solution.

(iii) Zn, Cd, Hg are considered as *d*-block elements but not as transition elements.

(b) Calculate the spin-only moment of Co^{2+} (Z = 27) by writing the electronic configuration of Co and Co^{2+}.

OR

(a) Give three points of difference between lanthanoids and actinoids.

(b) Give reason and select one atom/ion which will exhibit asked property :

(i) Sc^{3+} or Cr^{3+} (exhibit diamagnetic behaviour)

(ii) Cr or Cu (high melting and boiling point)

37. (a) Out of *t*-butyl alcohol and *n*-butanol, which one will undergo acid catalysed dehydration faster and why?

(b) Carry out the following conversions :

(i) Phenol to salicylaldehyde

(ii) *t*-Butyl chloride to *t*-butyl ethyl ether

(iii) Propene to propanol

OR

(a) Give the mechanism for the formation of ethanol from ethene.

(b) Predict the reagent for carrying out the following conversions :

(i) Phenol to benzoquinone

(ii) Anisole to *p*-bromoanisole

(iii) Phenol to 2,4,6-tribromophenol

SOLUTIONS

1. Stereochemical aspects of nucleophilic substitution reaction in S_N1 proceeds with racemisation.

2. Polarimeter is used for measuring the angle by which the plane polarised light is rotated.

3.
$$\underset{\text{2-Bromopentane}}{CH_3-CH_2-CH_2-\overset{\overset{Br}{|}}{CH}-CH_3} + KOH_{(alc.)} \longrightarrow$$
$$\underset{\substack{\text{Pent-2-ene}\\\text{(Major)}}}{CH_3-CH_2-CH=CH-CH_3} + \underset{\substack{\text{Pent-1-ene}\\\text{(Minor)}}}{CH_3-CH_2-CH_2-CH=CH_2}$$

4. Iodoform (CHI_3) is used as a mild antiseptic.

5.
$$\underset{\text{Anisole}}{C_6H_5OCH_3} + HI \longrightarrow \underset{\text{Phenol}}{C_6H_5OH} + CH_3I$$

6. Liquid *A*

7. Zinc

8. No

9. $CH_3-\overset{\overset{Cl}{|}}{CH}-CH_2$

10. Branched hydrocarbon chain

11. (b) : The increasing order of basicity of the given compounds are $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > C_6H_5NH_2$.

There is a subtle interplay of the inductive effect, solvation effect and steric hindrance of alkyl groups which decides the basic strength of alkyl amines in the aqueous state.

12. (d) : Iodoform test is given by only those carbonyl compounds which have $CH_3-\overset{\overset{O}{\|}}{C}-$ group or alcohols which have $CH_3-\overset{\overset{OH}{|}}{CH}-$ in their structure.

13. (c)

14. (c) : Hardening of leather in tanning industry is based on mutual coagulation.

15. (a)

16. (c) : Au and Ag dissolve in NaCN solution to form their soluble complexes while the impurities remain unaffected which are filtered off.

17. (b) : Due to small size, the lone pairs of electrons on F-atoms repel the bond pair between F-atoms. Therefore, F—F bond in F_2 molecule is weak.

18. (a)

19. (a) : Sucrose is disaccharide and its two monosaccharides are held together by a glycosidic linkage. Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, therefore, sucrose is a non-reducing sugar.

20. (a) : Molecularity is two because two molecules of the reactants are involved in the given elementary reaction.

21. (a) *Refer to answer 8, Page no. 267* (MTG CBSE Champion Chemistry Class 12).

(b) *Refer to answer 6, Page no. 267* (MTG CBSE Champion Chemistry Class 12).

OR

Soap has a hydrophobic part (hydrocarbon) that attracts dirt, grease oil, etc. whereas hydrophilic part (— COONa) attracts water that take oil, dirt and grease. Soaps do not work well with hard water because Mg^{2+} and Ca^{2+} ions of hard water react with soap to form magnesium and calcium salts of fatty acids which are insoluble in water and form scum.

$$\underset{\text{Soap}}{2C_{17}H_{35}COONa} + CaCl_2 \rightarrow 2NaCl + \underset{\substack{\text{Insoluble calcium}\\\text{stearate (soap)}}}{(C_{17}H_{35}COO)_2Ca}$$

22. Molality (m) of urea solution

$$= \frac{w \times 1000}{M \times \text{Mass of solvent}} = \frac{5 \times 1000}{60 \times 95} = 0.877 \text{ m}$$

Osmotic pressure (π) = CRT

$$= 0.877 \times 0.0821 \times 300 = 21.6 \text{ atm}$$

OR

$$\text{Molality } (m) \text{ of urea} = \frac{75 \times 1000}{60 \times 100} = 1.25 \text{ m} \quad \text{...(i)}$$

$$\text{Molality of substance, } Z = \frac{42.75 \times 1000}{\text{Molar mass} \times 100}$$

$$= \frac{427.5}{\text{Mol. mass}} \quad \text{...(ii)}$$

As both the solutions have same depression in freezing point so they have same molality.

From eqn. (i) and (ii), we get

$$1.25 = \frac{427.5}{\text{Molar mass}}$$

Molar mass of $Z = 342$ g/mol

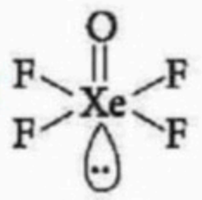
23. (a) The reaction is of first order.

(b) Rate = $k[A]$ for first order reaction.

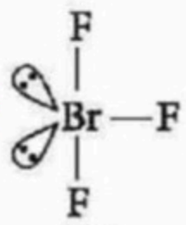
$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]_t}$$

At infinite time

$$t_\infty = \frac{2.303}{k}\log\frac{0}{[A]_t}$$

24. (a) 

$XeOF_4$

(b) 

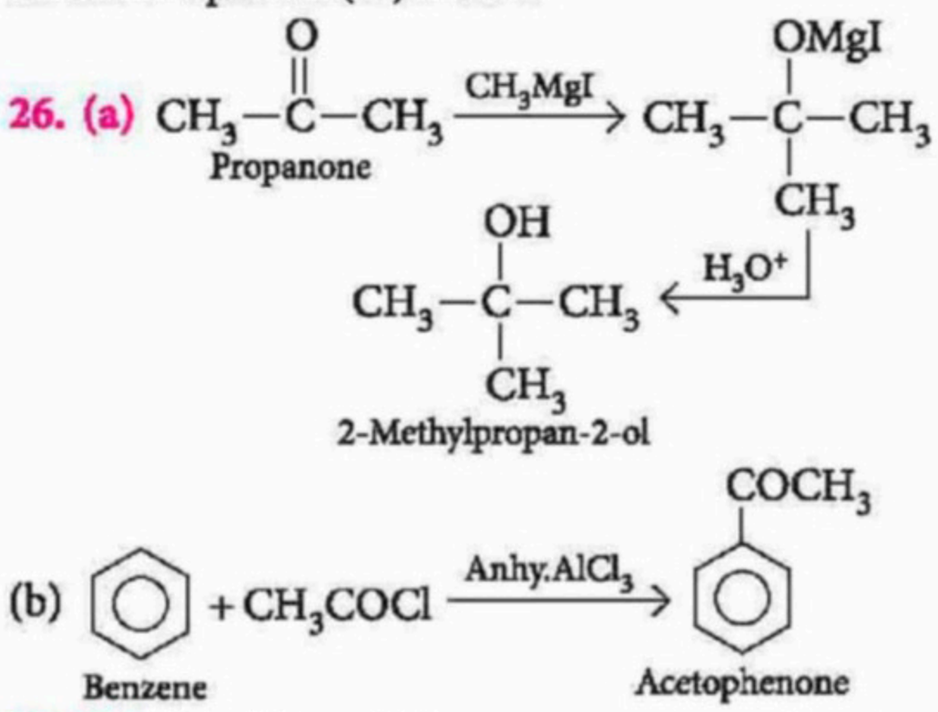
BrF_3

25. (a) $K_2[Zn(OH)_4]$

Potassium tetrahydroxidozincate(II)

(b) $[Pt(NH_3)_6]Cl_4$

Hexaammineplatinum(IV) chloride

26. (a) 

Propanone

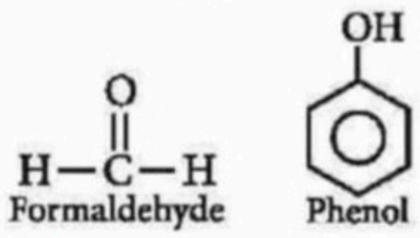
2-Methylpropan-2-ol

(b)

Benzene

Acetophenone

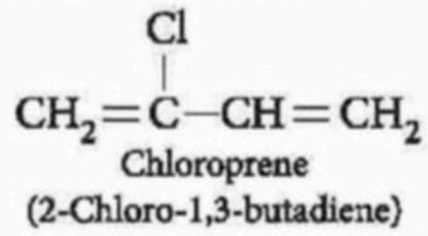
27. (a) Bakelite: Monomers are phenol and formaldehyde.



Formaldehyde

Phenol

(b) Neoprene : Neoprene or polychloroprene is formed by the polymerisation of chloroprene.



Chloroprene

(2-Chloro-1,3-butadiene)

28. (a) $CH_3COOH \xrightarrow[\Delta]{NH_3} \underset{(A)}{CH_3CONH_2} \xrightarrow{NaOBr} \underset{(B)}{CH_3NH_2}$

(b) $C_6H_5NO_2 \xrightarrow{Fe + HCl} \underset{(A)}{C_6H_5NH_2} \xrightarrow[0\text{-}5°C]{NaNO_2 + HCl} \underset{(B)}{C_6H_5N_2^+Cl^-}$

(c) $C_6H_5\overset{+}{N}_2Cl^- \xrightarrow[\Delta]{CuCN} \underset{(A)}{C_6H_5CN} \xrightarrow{H_2O/H^+} \underset{(B)}{C_6H_5COOH}$

OR

(a) (i) *Refer to answer 42, Page no. 228* (MTG CBSE Champion Chemistry Class 12).

(ii) *Refer to answer 60 (ii), Page no. 230* (MTG CBSE Champion Chemistry Class 12).

(b) Decreasing order of boiling points of given compounds :

Butanol > Butanamine > Butane

29. (a) Actually, glucose exists in the cyclic hemiacetal form with only a small amount (< 0.05%) of the open chain form. Since, the concentration of the open chain form is low and its reaction with 2,4-DNP is reversible, therefore, formation of 2,4-DNP derivative cannot disturb the equilibrium to regenerate more of the open chain form from the cyclic hemiacetal form and hence, does not give this test.

(b) The two strands in DNA molecule are held together by the hydrogen bonds between purine base of one strand and pyrimidine base of the other and *vice versa*. Because of different sizes and geometries of the bases, the only possible pairing in DNA are G (guanine) and C (cytosine) through three H-bonds, *i.e.*, (C ≡ G) and between A (adenine) and T (thymine) through two H-bonds (*i.e.*, A = T) . Due to this base-pairing principle, the sequence of bases in one strand automatically fixes the sequence of bases in the other strand. Thus, the two strands are complementary and not identical.

(c) The basic structural difference between starch and cellulose is of linkage between the glucose units. In starch, there is α-*D*-glycosidic linkage. Both the components of starch-amylose and amylopectin are polymers of α-*D*-glucose. On the other hand, cellulose is a linear polymer of β-*D*-glucose in which C1 of one glucose unit is connected to C4 of the other through β-*D*-glycosidic linkage.

30. (a) Due to the presence of a lone pair of electrons on the sulphur atom, sulphurous acid can be easily oxidised to sulphuric acid therefore, it acts as a reducing agent.

$$H_2O + Br_2 + H_2SO_3 \longrightarrow 2HBr + H_2SO_4$$

(b) *Refer to answer 88, Page no. 110* (MTG CBSE Champion Chemistry Class 12).

(c) As the size of noble gases increases, van der Waals' forces of attraction increase accordingly and hence, the boiling point increases from He to Rn.

OR

(a) $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

(b) $XeF_6 + KF \longrightarrow K^+ [XeF_7]^-$

(c) $4I^-_{(aq)} + 4H^+_{(aq)} + O_{2(g)} \longrightarrow 2H_2O + 2I_2$

31. (a) NaCN is used as a depressant in froth floatation process which selectively prevents ZnS from coming to the froth but allows PbS to come with the froth.

(b) During the metallurgy of copper from copper pyrites, $CuFeS_2$, its roasting gives FeO besides Cu_2O and SO_2.

$$\underset{\text{(Copper pyrites)}}{4CuFeS_{2(s)}} + 11O_{2(g)} \rightarrow 4FeO_{(s)} + 2Cu_2O_{(s)} + 8SO_{2(g)}$$

To remove FeO, SiO_2 is added to form slag.

$$\underset{\text{(Basic oxide)}}{FeO} + \underset{\text{(Acidic oxide)}}{SiO_2} \rightarrow \underset{\text{Slag}}{FeSiO_3}$$

(c) *Refer to answer 86, Page no. 93* (MTG CBSE Champion Chemistry Class 12).

32.

Property	Physisorption	Chemisorption
Enthalpy	Low enthalpy, is the order of 20-40 kJ mol^{-1}.	High enthalpy, is the order of 80-240 kJ mol^{-1}.
Reversibility	Reversible process.	Irreversible process.
Effect of temperature	With the increase in temperature, extent of adsorption decreases because adsorption is a exothermic process and kinetic energy of gas molecules increases with temperature.	Chemisorption first increases with temperature upto a certain extent and then decreases. A gas adsorbed at low temperature by physical adsorption may change into chemisorption at high temperature.

33. (a) For a reaction involving a solid reactant or catalyst, the smaller is the particle size *i.e.*, greater is the surface area, the faster is the reaction. therefore, on reducing the surface area, rate of reaction is reduced.

(b) A catalyst generally increases the speed of a reaction without itself being consumed in the reaction. In case of reversible reactions, a catalyst helps to attain the equilibrium quickly without disturbing the state of equilibrium.

(c) The rate of reaction increases with increase of temperature. In most of the cases, the rate of reaction becomes nearly double for 10° rise of temperature. In some cases, reactions do not take place at room temperature but takes place at higher temperature.

34. Given, $M_2 = 176\ g\ mol^{-1}$, $\Delta T_f = 1.5°C$
$w_1 = 75\ g$, $K_f = 3.9\ K\ kg\ mol^{-1}$, $w_2 = ?$

$$\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$$

$$w_2 = \frac{\Delta T_f \times M_2 \times w_1}{K_f \times 1000} = \frac{1.5 \times 176 \times 75}{3.9 \times 1000} = 5.077\ g$$

35. (a) $Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

Here, $n = 2$

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$= 0.34 - (-0.76) = 1.1\ V$

$F = 96500\ C\ mol^{-1}$

$\Delta_r G^\circ = -nFE^\circ_{cell} = -2 \times 1.1 \times 96500 = -212300\ J\ mol^{-1}$

$= -212.3\ kJ\ mol^{-1}$

(b) The two advantages of fuel cells are :

(i) They produce electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%.

(ii) They are pollution free.

OR

(a) (i) Silver wire at 30°C allows greater conduction of electricity than 60°C because with increase in temperature metallic conduction decreases due to vibration of kernels.

(ii) 0.1 M acetic acid solution allows greater conduction of electricity because with dilution degree of dissociation increases and hence, number of ions increases.

(iii) KCl solution at 50°C will have greater conductance. This is because ionic mobilities increases with increase in temperature.

(b)

S.No.	Electrochemical cell	Electrolytic cell
1.	It is a device to convert chemical energy into electrical energy, *i.e.*, electrical energy is produced as a result of the redox reaction.	It is a device to convert electrical energy into chemical energy, *i.e.*, electrical energy is supplied to the electrolytic solution to bring about the redox reaction.
2.	It is based upon the redox reaction which is spontaneous *i.e.*, ΔG = –ve	The redox reaction is non-spontaneous and takes place only when electrical energy is supplied *i.e.*, ΔG = +ve.

36. (a) (i) Cu(I) compounds have completely filled *d*-orbitals and there are no vacant *d*-orbitals for

promotion of electrons whereas in Cu(II) compounds have one unpaired electron which is responsible for colour formation.

(ii) In aqueous solution,

$$\underset{\text{Dichromate ion (Orange red)}}{Cr_2O_7^{2-}} + H_2O \rightleftharpoons \underset{\text{Chromate ion (Yellow)}}{2CrO_4^{2-}} + 2H^+$$

When an acid is added (*i.e.*, pH of solution decreased), the concentration of H^+ ions is increased and the reaction proceeds in the backward direction producing an orange red dichromate solution.

(iii) Zn, Cd, Hg are considered as *d*-block elements but not as transition elements because they do not have partly filled *d*-orbitals in their atomic state or their common oxidation states (*i.e.*, Zn^{2+}, Cd^{2+}, Hg^{2+}).

(b) $Co = [Ar]3d^7 4s^2$

$Co^{2+} = [Ar]3d^7$

i.e., there are three unpaired electrons ($n = 3$).

Hence, $\mu = \sqrt{n(n+2)}$ B.M. $= \sqrt{3(3+2)} = 3.87$ B.M.

OR

(a) (i) Difference between lanthanoids and actinoids are following :

(i) Electronic configuration : The general electronic configuration of lanthanoids is $[Xe]4f^{1-14}\ 5d^{0-1}\ 6s^2$ whereas, that of actinoids is $[Rn]\ 5f^{1-14}\ 6d^{0-1}\ 7s^2$. Thus, lanthanoids involve the filling of 4*f*-orbitals whereas, actinoids involve the filling of 5*f*-orbitals.

(ii) Oxidation states : Lanthanoids have principal oxidation state of +3. In addition, the lanthanoids show limited oxidation states such as +2, +3 and +4 because of large energy gap between 4*f* and 5*d* subshells. On the other hand, actinoids show a large number of oxidation states because of small energy gap between 5*f* and 6*d* subshells.

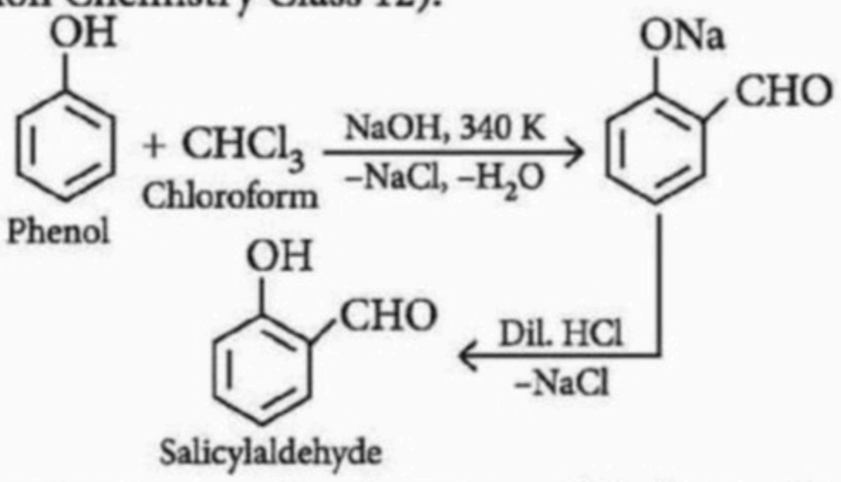
(iii) Chemical reactivity : First few members of lanthanoids are quite reactive almost like calcium, whereas, actinoids are highly reactive metals especially in the finely divided state. Lanthanoids react with dilute acids to liberate H_2 gas whereas actinoids react with boiling water to give a mixture of oxide and hydride.

(b) (i) Sc^{3+} has $3d^0$ outer electronic configuration, therefore it is diamagnetic in nature whereas Cr^{3+} has $3d^3$ outer electronic configuration. So, it is paramagnetic due to presence of unpaired electrons.

(ii) In a particular series, the metallic strength increases upto middle with increasing number of unpaired electrons, *i.e.*, upto d^5 configuration. After Cr, the number of unpaired electrons goes on decreasing. Accordingly, the m.pt and b.pt. decrease after middle (Cr) because of increasing pairing of electrons.

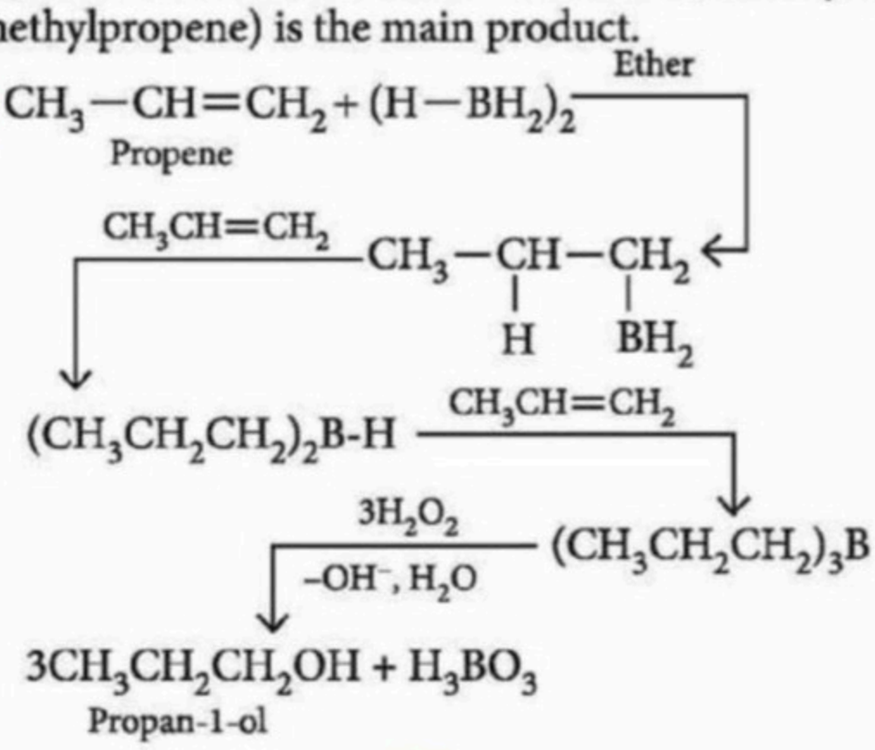
37. (a) *Refer to answer 73, Page no. 188* (MTG CBSE Champion Chemistry Class 12).

(b) (i)



(ii) The given conversion is not possible by treating sodium ethoxide with *t*-butyl chloride or bromide since, under these conditions an alkene *i.e.*, isobutylene (2-methylpropene) is the main product.

(iii)



OR

(a) *Refer to answer 53, Page no. 186* (MTG CBSE Champion Chemistry Class 12).

(b) (i) *Refer to answer 58 (i), Page no. 186* (MTG CBSE Champion Chemistry Class 12).

(ii) *Refer to answer 83, Page no. 189* (MTG CBSE Champion Chemistry Class 12).

(iii) *Refer to answer 51 (ii), Page no. 186* (MTG CBSE Champion Chemistry Class 12).

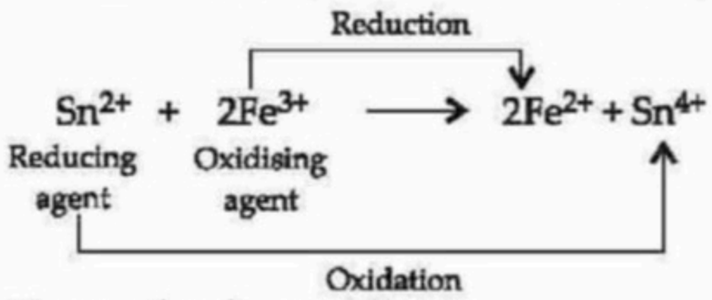
Essentials of

- Redox Reactions
- The *s*-Block Elements
- The *p*-Block Elements

CLASS XI

REDOX REACTIONS

- Redox reaction (Oxidation-reduction)



- Types of redox reactions :
  - **Combination reaction :**

$$\overset{0}{3Mg} + \overset{0}{N_2} \xrightarrow{\Delta} \overset{+2\ -3}{Mg_3N_2}$$

  - **Decomposition reaction :**

$$\overset{+1\ +5\ -2}{2KClO_3} \xrightarrow{\Delta} \overset{+1\ -1}{2KCl} + \overset{0}{3O_2}$$

  - **Displacement reaction :**
    (a) Metal displacement :

$$\overset{+2\ +6\ -2}{CuSO_4} + \overset{0}{Zn} \longrightarrow \overset{0}{Cu} + \overset{+2\ +6\ -2}{ZnSO_4}$$

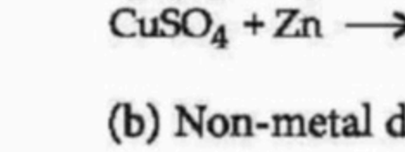
(b) Non-metal displacement :

$$\overset{0}{2Fe} + \overset{+1\ -2}{3H_2O} \xrightarrow{\Delta} \overset{+3\ -2}{Fe_2O_3} + \overset{0}{3H_2}$$

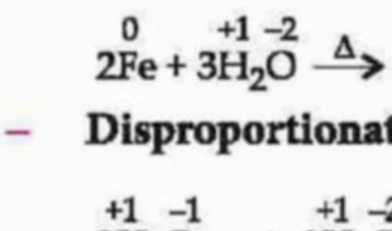
  - **Disproportionation reaction :**

$$\overset{+1\ -1}{2H_2O_2} \longrightarrow \overset{+1\ -2}{2H_2O} + \overset{0}{O_2}$$

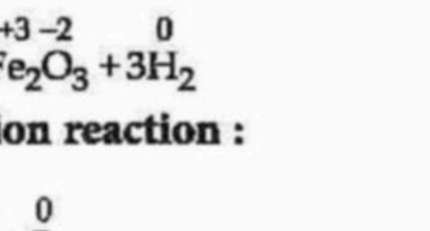
- In C_3O_2, oxidation number of carbon is 4/3.
- In Br_3O_8, oxidation number of bromine is 16/3.
- In $Na_2S_4O_6$, oxidation number of sulphur is 2.5.
- The element having fractional oxidation state is realised to present in different oxidation states.



C_3O_2 (Carbon suboxide)



Br_3O_8
(Tribromooctaoxide)



$S_4O_6^{2-}$
(Tetrathionate ion)

- In redox systems, the titration method can be adopted to determine the strength of a reductant/ oxidant using a redox sensitive indicator.
- MnO_4^- acts as the self-indicator.
- $Cr_2O_7^{2-}$, which is not a self-indicator but oxidises the indicator substance diphenylamine just after the equivalence point to produce an intense blue colour thus signalling the end point.
- Iodine itself gives an intense blue colour with starch and has a very specific reaction with thiosulphate ions ($S_2O_3^{2-}$), which is a redox reaction.
- $2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$
- $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$

THE *s*-BLOCK ELEMENTS

- **Alkali metals :** [noble gas]ns^1
- **Alkaline earth metals :** [noble gas]ns^2
- **Chemical properties of alkali metals :**

$4Li + O_2 \rightarrow 2Li_2O$ (Oxide)

$2Na + O_2 \rightarrow Na_2O_2$ (Peroxide)

$M + O_2 \rightarrow MO_2$ (Superoxide) (where, M = K, Rb, Cs)

$2M + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2$ [M = an alkali metal]

$2M + H_2 \xrightarrow{\Delta} 2M^+H^-$

$2M + X_2 \rightarrow 2M^+X^-$

$M + (x + y)NH_3 \rightarrow \underset{\text{ammoniated cation causes conductivity}}{[M(NH_3)_x]^+} + \underset{\text{ammoniated electron responsible for blue colour and paramagnetism}}{[e(NH_3)_y]^-}$

$M_2O + H_2O \rightarrow 2M^+ + 2OH^-$

$M_2O_2 + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2O_2$

$2MO_2 + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2O_2 + O_2$

$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$

$2NaNO_3 \rightarrow 2NaNO_2 + O_2$

- **Some important reactions :**

$2NH_3 + H_2O + CO_2 \rightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + NaHCO_3$

$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + 2H_2O$

$Na_2CO_3 \cdot 10H_2O \xrightarrow{375\ K} Na_2CO_3 \cdot H_2O + 9H_2O$

$Na_2CO_3 \cdot H_2O \xrightarrow{>373\ K} Na_2CO_3 + H_2O$

$Na_2CO_3 + H_2O + CO_2 \rightarrow 2NaHCO_3$

- **Chemical properties of alkaline earth metals :**

$M + X_2 \rightarrow MX_2$ (X = F, Cl, Br, I)

$BeO + C + Cl_2 \underset{}{\overset{600\text{–}800\ K}{\rightleftharpoons}} BeCl_2 + CO$

$2BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$

$M + 2HCl \rightarrow MCl_2 + H_2$

$M + (x + y)NH_3 \rightarrow [M(NH_3)_x]^{2+} + 2[e(NH_3)_y]^-$

$MO + H_2O \rightarrow M(OH)_2$

$Be(OH)_2 + 2OH^- \rightarrow [Be(OH)_4]^{2-}$

Beryllate ion

$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$

$2M(NO_3)_2 \rightarrow 2MO + 4NO_2 + O_2$

[M = Be, Mg, Ca, Sr, Ba)

- **Important reactions :**

$CaCO_3 \underset{}{\overset{heat}{\rightleftharpoons}} CaO + CO_2$

$CaO + H_2O \rightarrow Ca(OH)_2$

$CaO + CO_2 \rightarrow CaCO_3$

$CaO + SiO_2 \rightarrow CaSiO_3$

$6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$

$2Ca(OH)_2 + 2Cl_2 \rightarrow CaCl_2 + Ca(OCl_2) + 2H_2O$

Bleaching powder

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

$CaCO_3 \xrightarrow{1200\ K} CaO + CO_2$

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

$2(CaSO_4 \cdot 2H_2O) \rightarrow 2(CaSO_4) \cdot H_2O + 3H_2O$

THE *p*-BLOCK ELEMENTS

- **Electronic configuration :** $ns^2np^{1\text{-}6}$ (except for He)
- **Chemical properties :**

$4E + 3O_2 \xrightarrow{\Delta} 2E_2O_3$

$2E + N_2 \xrightarrow{\Delta} 2EN$

$2Al + 6HCl \rightarrow 2Al^{3+} + 6Cl^- + 3H_2$

$2Al + 2NaOH + 6H_2O \rightarrow 2Na^+[Al(OH)_4]^- + 3H_2$

Sodium tetrahydroxoaluminate(III)

$2E + 3X_2 \rightarrow 2EX_3$ (X = F, Cl, Br, I)

$F_3B + :NH_3 \longrightarrow F_3B \leftarrow NH_3$

$Na_2B_4O_7 + 7H_2O \rightarrow 2NaOH + 4H_3BO_3$

Orthoboric acid

$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$

Sodium metaborate — Boric anhydride

$Na_2B_4O_7 + 2HCl + 5H_2O \rightarrow 2NaCl + 4B(OH)_3$

$B(OH)_3 + 2HOH \rightarrow [B(OH)_4]^- + H_3O^+$

$H_3BO_3 \xrightarrow{\Delta} HBO_2 \xrightarrow{\Delta} B_2O_3$

$4BF_3 + 3LiAlH_4 \rightarrow 2B_2H_6 + 3LiF + 3AlF_3$

$2NaBH_4 + I_2 \rightarrow B_2H_6 + 2NaI + H_2$

$2BF_3 + 6NaH \xrightarrow{450\ K} B_2H_6 + 6NaF$

$B_2H_6 + 3O_2 \rightarrow B_2O_3 + 3H_2O$

$B_2H_6 + 6H_2O \rightarrow 2B(OH)_3 + 6H_2$

$B_2H_6 + 2NMe_3 \rightarrow 2BH_3 \cdot NMe_3$

$B_2H_6 + 2CO \rightarrow 2BH_3 \cdot CO$

$3B_2H_6 + 6NH_3 \rightarrow 3[BH_2(NH_3)_2]^+[BH_4]^- \xrightarrow{Heat} 2B_3N_3H_6 + 12H_2$

Borazine (Inorganic benzene)

$2MH + B_2H_6 \rightarrow 2M^+[BH_4]^-$ (M = Li or Na)

$Sn + 2H_2O \xrightarrow{\Delta} SnO_2 + 2H_2$

$SiCl_4 + 4H_2O \xrightarrow{-4HCl} Si(OH)_4$

Silicic acid

- **Important reactions :**

$2C + O_2 \xrightarrow{\Delta} 2CO$

$HCOOH \xrightarrow[conc.\ H_2SO_4]{373\ K} H_2O + CO$

$C + H_2O \xrightarrow{473\text{-}1273\ K} \underbrace{CO + H_2}_{\text{Water gas}}$

$2C + O_2 + 4N_2 \xrightarrow{1273\ K} \underbrace{2CO + 4N_2}_{\text{Producer gas}}$

$3CO + Fe_2O_3 \xrightarrow{\Delta} 2Fe + 3CO_2$

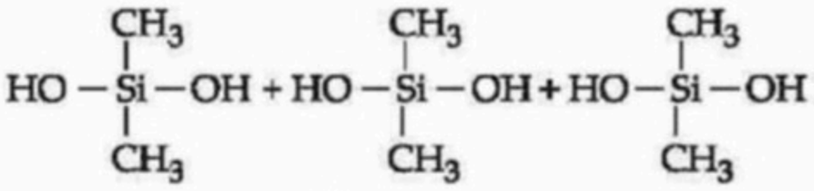
$CO + ZnO \xrightarrow{\Delta} Zn + CO_2$

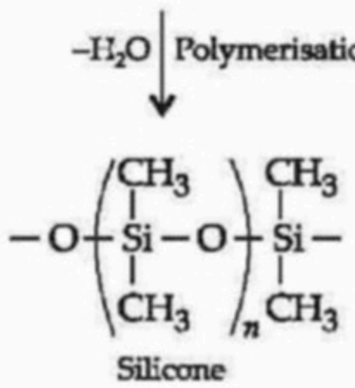
$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$

$2CH_3Cl + Si \xrightarrow[570\ K]{Cu\ powder} (CH_3)_2SiCl_2$

$(CH_3)_2SiCl_2 \xrightarrow[-2HCl]{+2H_2O} (CH_3)_2Si(OH)_2$





Silicone

MONTHLY TEST DRIVE

This specially designed column enables students to self analyse their extent of understanding of all chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

PRACTICE PAPER

Total Marks : 120 **Time Taken : 60 Min.**

NEET

Only One Option Correct Type

1. The volume of a colloidal particle, V_c as compared to the volume of a solute particle in a true solution V_s approximately could be
(a) 1 (b) 10^{23} (c) 10^{-3} (d) 10^{3}

2. On the basis of following reactions and conditions,
$PbO_2 \rightarrow PbO$; $\Delta G_{298\,K} < 0$
$SnO_2 \rightarrow SnO$; $\Delta G_{298\,K} > 0$
most probable oxidation state of Pb and Sn will be
(a) Pb^{4+}, Sn^{4+} (b) Pb^{4+}, Sn^{2+}
(c) Pb^{2+}, Sn^{2+} (d) Pb^{2+}, Sn^{4+}

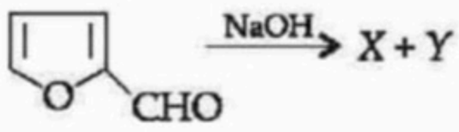
3. The pair in which both species have same magnetic moment (spin only value) is
(a) $[Cr(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$
(b) $[Cr(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{2+}$
(c) $[Mn(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$
(d) $[CoCl_4]^{2-}$, $[Fe(H_2O)_6]^{2+}$

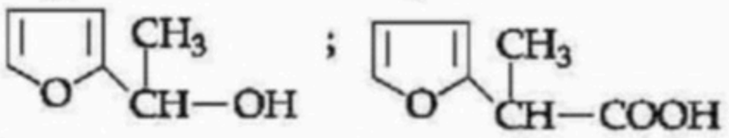
4. In a solid *AB* having the NaCl structure, *A* atoms occupy the corners of the cubic unit cell. If all the face-centred atoms along one of the axes are removed, then the resultant stoichiometry of the solid is
(a) AB_2 (b) A_2B (c) A_4B_3 (d) A_3B_4

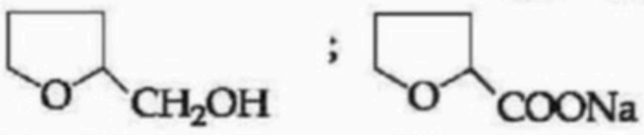
5. The correct IUPAC name of compound $[Pt(en)_2Cl(ONO)]^{2+}$ is
(a) chloridodiethylenediaminenitritoplatinum(IV) ion
(b) *bis*(ethylenediamine)chloridonitro-O-platinum(IV) ion
(c) chlorido*bis*(ethylenediamine)nitrito-O-platinum(IV) ion
(d) chloridodiethylenediaminenitro-O-platinum (IV) ion.

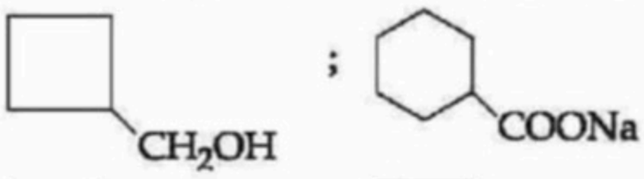
6. The radioactive isotope, $^{60}_{27}Co$ which is used in the treatment of cancer can be made by (n, p) reaction. For this reaction the target nucleus is
(a) $^{60}_{27}Co$ (b) $^{59}_{28}Ni$
(c) $^{59}_{27}Co$ (d) $^{60}_{28}Ni$

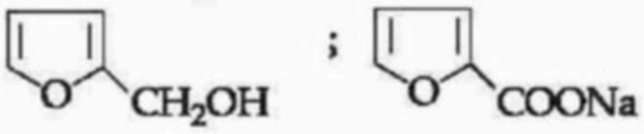
7. Identify *X* and *Y*.



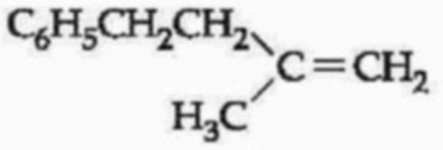
X *Y*
(a) 

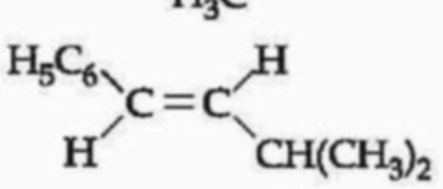
(b) 

(c) 

(d) 

8. The major product of the following reaction is
$C_6H_5CH_2CH(OH)CH(CH_3)_2 \xrightarrow{\text{conc. } H_2SO_4} ?$
(a)

(b) 

(c) 

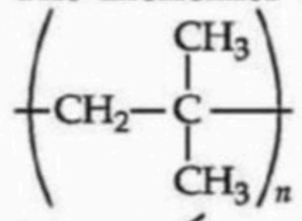
(d) none of these.

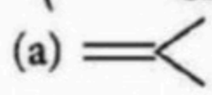
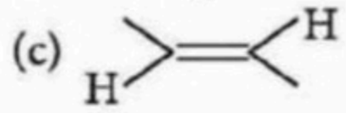
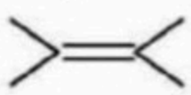
9. Which one of the following is a non-steroidal hormone?
   (a) Estradiol
   (b) Prostaglandin
   (c) Progesterone
   (d) Estrone

10. Which of the following statements indicates the cyclic structure of glucose?
   (a) Glucose gets oxidised to gluconic acid on reaction with bromine water.
   (b) Glucose on heating with HI forms *n*-hexane.
   (c) Glucose does not give 2, 4-DNP test.
   (d) All of the above.

11. Which of the following reactions takes place in fusion zone in the blast furnace during the extraction of iron?
   (a) $CaCO_3 \longrightarrow CaO + CO_2$
   (b) $CO_2 + C \longrightarrow 2CO$
   (c) $C + O_2 \longrightarrow CO_2$
   (d) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

12. The monomer unit for the following polymer is



(a) 
(b) 
(c) 
(d) 

Some Facts Behind the Chemistry of Insect Repellents

Insect repellents are used to repel mosquitoes, ticks, flies and other biting insects. These repellents affect an insect senses such as smell and taste to prevent it from finding a human or animal host.

WHAT ATTRACTS INSECTS?

1-Octen-3-ol

MOLECULAR FORMULA

$C_8H_{16}O$

This chemical is present in human sweat and breath, and is thought to attract biting insects such as mosquitoes. It is often used in combination with CO_2 in mosquitoes traps. It is also known as mushroom alcohol because it is found in mushrooms.

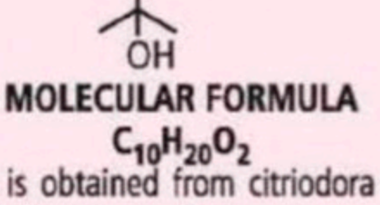
COMMON INGREDIENTS IN INSECT REPELLENTS

DEET

***N, N*-Diethyl-meta-toluamide**

MOLECULAR FORMULA

$C_{12}H_{17}NO$



- It is the most common active ingredient.
- 2-8 hours protection (20-30% solution).
- 10-30% solution safe for adults. <10% recommended for children up to 12.
- Effective for mosquitoes, ticks, flies and other biting insects.

CITRIODIOL

***p*-Menthane-3, 8-diol**

MOLECULAR FORMULA

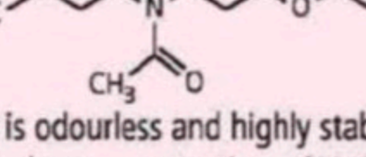
$C_{10}H_{20}O_2$

- It is obtained from citriodora of the lemon eucalyptus tree.
- Approximately 6 hours protection (10-20% solution).
- No adverse effects - irritation possible if contact with eyes occurs.
- Mosquitoes, flies and gnat repellent; also a miticide, killing insects and mites.

ICARIDIN OR PICARIDIN

MOLECULAR FORMULA

$C_{12}H_{23}NO_3$



- It is odourless and doesn't damage plastics.
- 2-8 hours protection (20% solution.)
- Used on human skin or clothing. These products may be pumps sprays, liquids, aerosols or wipes.
- Not a skin irritant, but can cause mild eye irritation on contact.
- Repels mosquitoes, ticks and chiggers.

IR3535

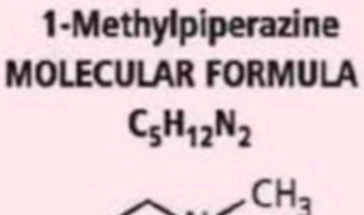
Ethyl butylacetylamino propionate

MOLECULAR FORMULA

$C_{11}H_{21}NO_3$

- It is odourless and highly stable.
- 7 hours protection (10-20% solution.)
- Not harmful when ingested or inhaled, although can irritate eyes on contact.
- Repels mosquitoes, ticks, body lice and biting flies.

HOW DO INSECT REPELLENTS WORK?



Unpleasent odour of repellents confuses insects by jamming their olfactory receptors which produces repellent effect.

Recent studies suggest that, after initially being exposed to the repellent DEET, insects can temporarily overcome or develop resistance to its repellent effect. This could have future implications for how the efficacy of repellents is determined.

AN INVISIBLE BUT A BUILT IN DEFENCE?

1-Methylpiperazine

MOLECULAR FORMULA :

$C_5H_{12}N_2$

Researchers showed that bacteria on human skin form 1-methylpiperazine that prevents mosquitoes from recognising presence of human.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

13. **Assertion :** The size of the heavier lanthanoid ions Dy^{3+} and Ho^{3+} are similar to that of Y^{3+}.
Reason : The lanthanoid contraction reduces the radii of the last four elements in the series below that of Y^{3+} in the preceding transition series.

14. **Assertion :** Decrease in the vapour pressure of water by adding 1.0 mol of sucrose to one kg of water is nearly similar to that produced by adding 1.0 mol of urea to the same quantity of water at the same temperature.
Reason : Decrease in the vapour pressure of solvent depends on the quantity of non-volatile solute present in the fixed amount of solvent, irrespective of its nature.

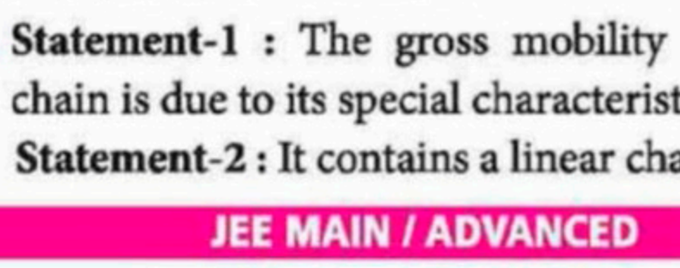
15. **Statement-1 :** The gross mobility of elastomer chain is due to its special characteristics.
Statement-2 : It contains a linear chain.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. The standard electrode potential of Cu/Cu^{2+} couple is –0.34 volt. At what concentration of Cu^{2+} ions will this electrode potential be zero?
(a) 3.12×10^{12} (b) 3.02×10^{-12}
(c) 5.66×10^{-5} (d) 5.66×10^{5}

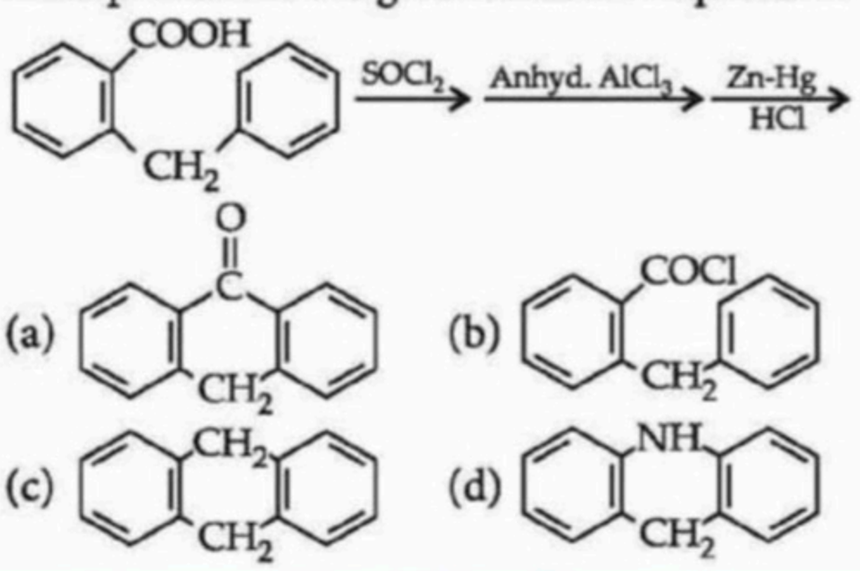
17. What would be the *Y* and *Z* in the following reaction sequence?



	Y	*Z*
(a)	Succinic acid	Adipic acid
(b)	Oxalic acid	Malonic acid
(c)	Glutaric acid	Adipic acid
(d)	Adipic acid	Succinic acid

18. The total vapour pressure of a 4 mole % solution of NH_3 in water at 293 K is 50.0 torr and the vapour pressure of pure water is 17.0 torr at this temperature. Applying Henry's law and Raoult's law, the total vapour pressure for a 5 mole % solution is
(a) 58.42 torr (b) 33 torr
(c) 42.1 torr (d) 52.25 torr.

19. Final product of the given reaction sequence is



More than One Options Correct Type

20. Protons accelerate the hydrolysis of esters. This is an example of
(a) a promoter
(b) a heterogeneous catalyst
(c) an acid base catalyst (d) an auto catalyst.

21. Which of the following statements are correct?
(a) TeO_2 is almost insoluble in water so that tellurous acid has not been characterised.
(b) BrF_3 is pyramidal in shape.
(c) Except CCl_4, other tetrahalides of group 14 are easily hydrolysed by water.
(d) There are only 12 bonding electrons available in diborane.

22. If same quantity of electricity is passed through three electrolytic cells containing $FeSO_4$, $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$, then
(a) the amount of iron deposited in $FeSO_4$ and $Fe_2(SO_4)_3$ are equal
(b) the amount of iron deposited in $FeSO_4$ is 1.5 times of the amount of iron deposited in $Fe(NO_3)_3$

Quotable Quote

"The pessimist sees difficulty in every opportunity. The optimist sees the opportunity in every difficulty."

WINSTON CHURCHILL

(c) the amount of iron deposited in $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$ are equal
(d) the same amount of gas is evolved in all three cases at the anode.

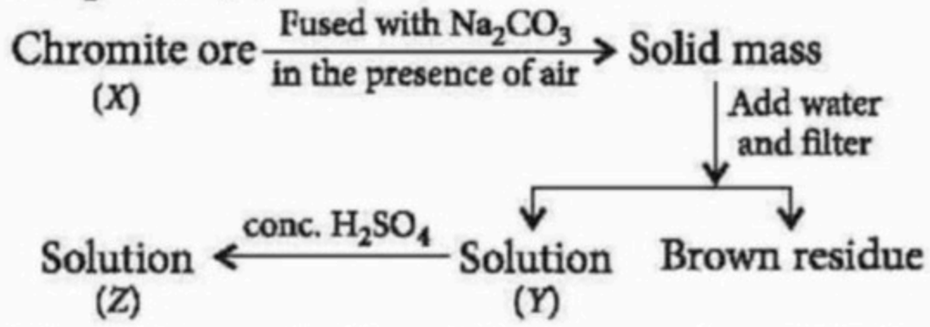
23. If the radius of Na^+ is 95 pm and that of Cl^- ion is 181 pm then
(a) co-ordination no. of Na^+ is 6
(b) co-ordination no. of Na^+ is 8
(c) length of the unit cell is 552 pm
(d) length of the unit cell is 380 pm.

Numerical Value Type

24. The number of monochlorinated products possible for free radical chlorination of 2, 2-dimethylbutane is _____.

25. Among the complex ions,
$[Co(NH_2CH_2CH_2NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$,
$[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$,
$[Co(NH_2CH_2CH_2NH_2)_2(NH_3)Cl]^{2+}$ and
$[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ions that show *cis-trans* isomerism is _____.

26. Following steps are involved in manufacturing of compound (*Z*).



The difference in the oxidation number of Cr in (*X*) and (*Z*) is _____.

Matrix Match Type

Questions 27-28 :

Drugs are chemical substances of low molecular mass. These interact with macromolecular targets to produce biological response. If biological response is therapeutic and useful then these chemicals are called medicines which are used for treatment, diagnosis and prevention of disease.

Column I		Column II	
P.	Naproxen	I.	Antifertility drug
Q.	Meprobamate	II.	Analgesic
R.	Terfenadine	III.	Neurological active drug
S.	Norethindrone	IV.	Antihistamines

27. Which of the following has correct combination considering column-I and column-II?
(a) P → II (b) Q → IV
(c) R → I (d) S → III

28. Which of the following has correct combination considering column-I and column-II?
(a) P → III (b) Q → I
(c) R → IV (d) S → II

Questions 29-30 :

Haloalkanes undergoes nucleophilic substitution reactions and elimination reactions. Reactions in which a stronger nucleophile displaces a weaker nucleophile are called nucleophilic substitution reactions. Elimination reactions occur when a strong base approaches to haloalkanes and tends to loose proton from β-carbon atom.

Column I		Column II	
P.	Reactions are concerted.	I.	S_N1
Q.	Carbocation is formed in the reaction.	II.	Both S_N2 and E2
R.	Polar protic solvent is used in the reaction.	III.	E2
S.	Reaction occurs at high temperature.	IV.	Both E2 and E1

29. Which of the following has correct combination considering column-I and column-II?
(a) P → II (b) Q → III
(c) R → IV (d) S → I

30. Which of the following has correct combination considering column-I and column-II?
(a) P → I (b) Q → II
(c) R → III (d) S → IV

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

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< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

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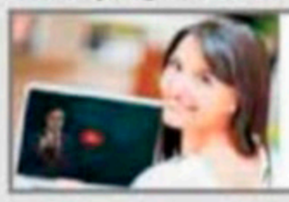

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